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Report and Recommendations

Public Hearings on Management of Water Resources within the Oldman River Basin

Alberta

Environment Council of Alberta

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MANAGEMENT OF WATER RESOURCES WITHIN THE OLDMAN RIVER BASIN

REPORT AND RECOMMENDATIONS

AUGUST 1979

Alberta
ENVIRONMENT COUNCIL OF ALBERTA
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Lieutenant Governor in Council
Legislative Building
EDMONTON Alberta

Honourable J. W. Cookson
Minister
Department of Environment
222 Legislative Building
EDMONTON Alberta

Dear Sirs:

I have the honour to transmit, herewith, the Report and Recommendations of the Environment Council of Alberta on Management of Water Resources within the Oldman River Basin, as required under Section 7 (1) (e) of The Environment Council Act (Chapter 125 R.S.A. 1970 with amendments to November 10, 1977).

I have the honour to be, Sirs,

Your obedient servant,

AW Platt

A. W. Platt
Chairman, Oldman River Basin Panel
Environment Council of Alberta

ACKNOWLEDGEMENTS

We would not have completed our task without the assistance and wholehearted co-operation of a great many men and women.

Of greatest importance were those who appeared at the Public Hearings and presented their views and detailed their experiences in all those areas related to water management. We are particularly appreciative of their patience and the thoughtfulness of the answers they gave to our many questions. The Council appreciates the level of detail which was apparent in many of the briefs. It is not possible to address every specific issue or bring forward every piece of evidence, but if specific references to materials included in the briefs are not made that should not be taken to indicate that the Council did not consider them in its deliberations, and that they were not useful.

Officials of the Departments of Environment, Agriculture, Recreation, Parks and Wildlife not only met with us, but those in Alberta Environment and Alberta Agriculture also spent a great deal of time preparing information we requested. All made substantial inputs to enable us to better understand the problems examined.

Research officers from the Federal Research Station at Lethbridge, along with their counterparts from Alberta Agriculture, initiated us into the mysteries of salinity, while others from the same institution helped in assessing the economic future of irrigated agriculture.

The Irrigation Council, and particularly the Secretariat, were most generous with their time and wisdom as we sought their counsel on more than one occasion. District managers enlightened us on many of the practical aspects of running an irrigation district.

A number of consultants who prepared reports not only explained the work they had done for the Management Committee, but also supplied additional information that was helpful to us in arriving at decisions. To those farmers, processors and others who freely granted us interviews and frankly discussed the issues we raised, we express our sincere thanks.

The leaders of both the Peigan and Blood Reserves made a sincere effort to explain to us their problems and their aspirations. We hope our report will make some contribution to helping them achieve their goals.

Finally, we wish to acknowledge with sincere thanks the work of the Council's staff. Those who arranged the Public Hearings and recorded the proceedings enabled us to concentrate on our job of listening to what was presented to us. Assistance from the library staff is gratefully acknowledged. Our research staff, consisting of Dave Buchwald, John Lilley and Johanna Jacks, we found to be competent, dedicated people who gave generously of their time and talents. To those competent ladies who typed and retyped the numerous drafts without a word of complaint, may we say, "Thank you very much."

HIGHLIGHTS

The rivers of the Oldman River Basin have provided water for the use of people, livestock, and industry. These consumptive uses have required relatively small amounts of the water available. The remaining surplus has been used for irrigation to supplement meagre rainfall that is characteristic of this part of Alberta in many years. The Environment Council concluded that this use pattern is the best and highest use of this renewable resource foreseeable at this time. Users for domestic and industrial consumption can afford to pay high prices for the small amount of water they require, but food producers can only afford relatively low prices for the large amounts they require.

In its deliberations, the Environment Council has been cognizant of the economic reality that there are limits as to what the farmer can pay and what the Alberta government should contribute to irrigation development. If the farmer is to remain competitive in the market place, he must not be saddled with costs that he cannot afford to pay. Similarly, the Government of Alberta, as custodian of all citizens' money, must assure itself that any contributions it makes will result in a reasonable return on the money invested. The Environment Council believes that these criteria have been met in the recommendations made in this report.

The environmental, social, and recreational aspects of water management were carefully considered in the deliberations of the Council. The environmental objectives were to preserve unique existing features and to enhance the opportunity for improving the environment around farmsteads and reservoirs. Adverse social impacts were kept to a minimum, but unfortunately some people will, of necessity, be disrupted. In so far as recreation is concerned, the objective was to retain the existing or potential recreational areas and to encourage the development of water-based recreation facilities particularly towards the eastern part of the basin. In the view of the Council, existing wildlife habitat and fisheries will be neither greatly enhanced nor adversely affected by the recommendations in this report, compared to the present situation.

The most important recommendation is that the rehabilitation of the irrigation water delivery system be completed with all reasonable speed. The objective would be to obtain 80 per cent delivery efficiency. This would make substantially more water available for higher per acre applications on presently irrigated farms, increased irrigation acres, or enhanced stream flows. Equally important would be the reduction in damage to soil by seepage and salinization. This recommendation has the support of the Phase I Study, the Management Committee and 53 briefs at the Public Hearings.

To expedite rehabilitation, the Environment Council has made several specific recommendations. The most significant are first, that Alberta Environment be responsible for the rehabilitation and maintenance costs of the Lethbridge Northern Irrigation District canal from the diversion point near Brocket to Keho Reservoir and the St. Mary Main Canal from Waterton Reservoir to Sauder Reservoir. The operation of the former would be the responsibility of the Lethbridge Northern Irrigation District, and of the latter of the St. Mary River Irrigation District. The estimated capital cost to Alberta Environment of rehabilitating these canals would be $85 million.

Second, the Council recommends that within the irrigation districts, except the Foothill Districts, rehabilitation be accelerated, and to expedite this the following be implemented. Minimum standards should be set by the Irrigation Council with the objective of reaching overall levels of delivery efficiency of 80 per cent. Maximum standards would be set by the districts and, to ensure that extravagant programs are not proposed and to achieve a greater degree of equity, the cost sharing should be changed over a three-year period from the present 86/14 to 75/25. Under this arrangement, the province would agree to make its contribution available upon request. The contribution the farmer has to make plus the supervision of the Irrigation Council assures that the money will be well used.

As a further incentive to move quickly towards improved efficiency, it is recommended that a wholesale water charge of 50 cents per acre foot be levied on irrigation districts where Alberta Environment has or will provide major headworks. The proceeds would go into a fund administered by the Planning and Research Secretariat of Alberta Agriculture with the assistance of the Irrigation Council. Proposals for use of the fund for projects to develop new irrigation technology, or new crops and their processing and marketing would be received from anyone who has a new idea that appears worthy of development.

It is impossible to estimate precise total costs since the amount of rehabilitation necessary to achieve the efficiency objective is unknown. The standards the farmers are willing to pay for is also unknown. The costs within the Oldman River Basin will probably range from $100 to $160 million. The farmers' share would, thus, range from $25 to $40 million and the government's from $75 to $120 million. The Environment Council recommends that a rehabilitation program be designed to reach completion no later than 1995. This should be considered a one-time investment by the province. After this date, district works become the continuing responsibility of irrigation farmers and their district boards.

Increasing farm efficiency to 75 per cent will require the efforts of all farmers. The Environment Council recommends that to assist them the present educational programs by Alberta Agriculture be continued and research on scheduling, salinity, and drainage be continued and co-ordinated with similar research by Agriculture Canada, as is presently the case. Individuals and companies with sufficient expertise should be encouraged to offer advice to individual farmers on a fee for service basis. The immediate use of meters at major diversion points on the delivery system as well as at representative farm delivery points should occur immediately to provide a beginning of a data base on water use.

In allocating water for the expansion of land to be irrigated, recommendations have been based on the requirement that the minimum streamflow criteria (360 cfs at Lethbridge, and 30 cfs on the Belly, Waterton, and St. Mary Rivers) be met. The apportionment obligations with Saskatchewan would also be met. It was assumed that the apportionment obligations would be based on 75 per cent of the flow of the Red Deer River and 50 per cent of the flow of the Bow River.

When the Environment Council considered increasing irrigated acreage and structures necessary to support such increases it found that the new acres that would benefit most from irrigation lie south of the Oldman River, particularly in the eastern part. There are more suitable acres than water available in this part of the basin. It appears that with canal rehabilitation and enlargement, construction of a major reservoir at Forty Mile Coulee, and minimum flow criteria of 30 cfs in the St. Mary, Waterton, and Belly Rivers below the diversion point, 465,000 acres can be irrigated in the St. Mary Project and 47,000 in the Foothills Districts. An additional 30,000 acres in the St. Mary Project could be irrigated by increasing storage in Chin Coulee Reservoir by 140,000 acre feet, but the capital cost of about $1,000 per acre is judged excessive at present irrigation efficiencies.

North of the Oldman River the reverse situation occurs. More water is available than land can be brought under irrigation at reasonable cost. In this area, up to 57,000 acres adjacent to or close by existing distribution facilities can be irrigated at relatively low cost. These, plus the present 110,000 acres, can be adequately serviced by the enlargement of the main canal, the enlargement of Keho Lake, and the construction of Mud Lake Reservoir. Expansion into new areas is judged too costly. The best prospect was Albion Ridge and the farmers there have made the judgement that they are not prepared to pay the costs involved, even though the district offered a high level of subsidy.

The Environment Council recommends that a 20,000 acre project on the Blood Indian Reserve proceed (part of the St. Mary Project) and the cost shared with the province on a 75/25 basis. Unfortunately, there is little opportunity for irrigation development on the Peigan Reserve. Other means must be found to assist them in their economic development.

The Environment Council recommends the immediate construction of Forty Mile Coulee Reservoir, as it will require considerable time to construct and is badly needed now. As suggested above, the Council also recommends the enlargement of Keho Lake and construction of Mud Lake Reservoir. The estimated cost of these three reservoirs is $66 million (1978 dollars). These recommendations are essentially similar to the near future proposals of the Management Committee.

The far future proposals of the Management Committee are, in the opinion of the Environment Council, possible from an engineering standpoint. However, the capital costs involved for the enlargement of Chin Coulee Reservoir at approximately $1,000 per incremental acre are marginal at present efficiency levels. The capital costs of onstream storage and the capital and ongoing operational costs of the Chin Pump are judged to be excessive in view of the returns obtained by irrigation farmers.

The estimated costs and acres that would be irrigated are as follows.
Provincial costs (in millions of 1978 dollars) are:

Rehabilitation and enlargement of canals	$ 85
Keho Lake Reservoir	6
Mud Lake Reservoir	24
Forty Mile Coulee Reservoir	36
Total	$ 151

The province's share of the costs of district rehabilitation will likely fall in the range of $75 to $120 million. Thus, total provincial costs will fall in the range of $226 to $271 million. If an increase of 140,000 acre feet of storage in Chin Coulee Reservoir becomes feasible an additional $32 million will be required. The totals then become $258 to $303 million.

The above facilities are expected to increase irrigated acres to the following levels:

	without Chin Coulee Reservoir	with Chin Coulee Reservoir
LNID	170,000	170,000
St. Mary Project	465,000	495,000
Foothills Districts	47,000	47,000
Private Onstream	74,000	74,000
Total	756,000	786,000

The estimated costs do not include any rehabilitation of headworks above Milk River Ridge Reservoir in the St. Mary system, recreational facilities, site beautification, or assistance to urban areas in water or sewage treatment facilities.

Substantial additional burdens have also been placed on the irrigation farmer. These are more difficult to estimate, but include the wholesale water charge and substantially increasing their share of the cost of rehabilitation.

The Environment Council is concerned with quality water in the basin. To prevent further deterioration and hopefully to improve the existing quality requires improvement in sewage treatment facilities in the Crowsnest Pass and tertiary treatment facilities at Lethbridge. While these measures would markedly improve water quality in the Oldman River, it would not solve the problem of the poor quality of water at Medicine Hat, which is due to the extremely high load of phosphate and consequent algae growth in the Bow River. This can only be rectified by treatment at Calgary. The Environment Council urges Alberta Environment to continue to locate point sources of pollution from whatever source in the Oldman River Basin and to take appropriate action to rectify the problems encountered. The recommendation of the Management Committee to allow no further development of feedlots on watercourses and to use wastewater for irrigation wherever possible is strongly supported by the Environment Council.

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1. INTRODUCTION

1.1 INTRODUCTION

For a number of years, the Province of Alberta has been concerned about water management in the Oldman River Basin. This concern intensified when all federal properties, works, and interests in the Bow River and the St. Mary Project came under provincial administration. Prior to April 1974, planning, management, and construction of irrigation works had been shared between the federal and provincial governments.

In 1974 the provincial government identified irrigation in southern Alberta as a high priority water use, with a first priority, an examination of the Oldman River Basin. At the same time, the provincial government allocated $200 million from the Heritage Savings Trust Fund for irrigation rehabilitation and expansion between 1974 and 1986.

The initial planning studies of the Oldman River Basin, known as the Phase I studies, were also begun in 1974 to determine current and estimated future water use requirements, available sources to meet these requirements, and the best way to ensure that the supply meets the demand. The Phase I studies were undertaken by the Planning Division of Alberta Environment (1976) through the creation of a Technical Advisory Committee which had input from federal and provincial departments, the Regional Planning Commission, industries, and municipalities.

Three major conclusions of the main Phase I report (Alberta Environment 1976), completed in June 1976, are:

1. Flow regulation reservoirs in the Oldman River Basin are economical if they provide ample water supply for irrigation purposes.
2. The current water shortages which are inhibiting the expansion of irrigation in the basin are due mainly to the deterioration of the irrigation districts' distribution facilities.
3. On the basis of existing water requirements, the present water supply systems do not provide an assured water supply.

Of the nine dam sites examined, the Three Rivers site was preferred largely because of storage costs. The study noted the preliminary nature of its review and pointed out missing data. It also recommended soliciting public reaction. Thus, when the Minister of Environment, the Hon. D. J. Russell, released the report and asked for public reaction, approximately 80 individuals, organizations, and local government bodies responded. In the meantime, it was decided that Phase II studies were warranted and that the public response should help to provide new direction for those studies.

New features of the Phase II studies were:

a. more comprehensive studies, covering most of the basin, which examined concerns such as social impacts;
b. a management committee, with a majority of non-public servants, to guide the study;
c. a commitment to public information and public consultation during the study.

To carry out its mandate, the Management Committee arranged for the preparation of 16 reports (see Appendix 1) covering 14 study areas to be completed during the following 12 months. These studies were undertaken mainly by consultants. While the reports were being prepared, the Committee held a series of meetings and workshops, and received briefs from residents. In addition, the Committee kept the public informed through news releases, and the distribution of the reports and study summaries to information centres. In August 1978, the Management Committee presented its recommendations to the Minister of Environment in a report entitled *Oldman River Final Report.* Concurrently, the Environment Council of Alberta was asked to hold Public Hearings on the Management of Water Resources within the Oldman River Basin.

The terms of reference for the Environment Council Hearings are: "Whereas past water shortages in the Oldman River Basin have indicated a need for improved management of the resource, the Environment Council of Alberta is therefore requested to:

1. Enquire into the conservation, management and utilization of water resources within the Oldman River Basin as outlined in the Report of the Oldman River Study Management Committee; giving particular attention to:
    (a) present water supply
    (b) present and future water requirements
    (c) the merits of alternative means of providing for future water requirements.
2. Hold Public Hearings at suitable locations throughout southern Alberta on the Report of the Oldman River Study Management Committee and report to the Minister of Environment as soon as possible."

The panel appointed to carry out this task consists of:
Dr. Arnold Platt of Cardston, *Chairman of the Panel.* Dr. Platt is a professional Agrologist, a Fellow of the Agricultural Institute of Canada, and has experience in plant breeding, commercial marketing, and land use.

Mr. Alistair D. Crerar of Edmonton, *Vice-Chairman of the Panel by statute.* Mr. Crerar, Chief Executive Officer of the Environment Council of Alberta, is an economist/planner.

Mr. Thomas A. Sissons, P. Eng., of Medicine Hat, *Member.* Mr. Sissons, a former Medicine Hat alderman, is Vice-President of I-XL Industries Limited.

Dr. Dixon Thompson of Calgary, *Member.* Dr. Thompson, a native of the Pincher Creek area, is an Associate Professor of Environmental Science in the Faculty of Environmental Design, University of Calgary.

To obtain the reaction of the public to the report of the Management Committee and their views on water management within the Oldman River Basin, the Environment Council held ten Public Hearings in eight centres in southern Alberta. Appendix 2 contains a list of information centres where transcripts of the Hearings are available.

In addition to the Hearings, the Environment Council met with a variety of agencies and consultants who had contributed to the preparation of the report of the Management Committee or who had a particular knowledge or involvement in critical aspects of water management in the area.

The Environment Council, in addition to the work of its staff, also had two consultants prepare reports on aspects that it felt required additional information. These reports, which are available from the Council, are: *Price-Quantity Relationships for Irrigation Water in Southern Alberta* by Marv Anderson & Associates (1979) and *The Economic Viability of Increased Beef Feeding in Alberta* by Meat Industry Research Services (1979). The Anderson report is an examination of the impact of price on the consumption of water in irrigation agriculture. The Meat Industry Research report is an examination of Alberta's market prospects for red meat and of the comparative advantage of Alberta in the production of red meats in competition with Ontario and the American midwest.

The Oldman River Basin Study and the ongoing South Saskatchewan River Basin Planning Study are part of a national trend towards increased understanding of our water resources and their management. A broad national data base is being established with major work done on the Fraser, Okanagan, Saskatchewan/Nelson, Qu'appelle, Souris, St. Lawrence, and St. John Rivers systems. In Alberta numerous systems have been studied including the Paddle, Vermilion, Red Deer, Bow and the Peace/Athabasca Rivers systems. A comparison with the progress of other countries can be made by referring to the summary of the proceedings from the March 1977 United Nations Conference on Water held at Mar Del Plata, Argentina. (See Appendix 8.)

Alberta Photographic Services

The Oldman River taken from the Lethbridge Golf Course.

1.2 THE PUBLIC HEARINGS

The Public Hearings were held in southern Alberta from November 6 to November 29, 1978.

Date	Location	Number of Briefs
November 6, 7	Lethbridge	23
November 9	Fort Macleod	15
November 14, 15	Picture Butte	29
November 17	Taber	14
November 20	Pincher Creek	26
November 21	Cowley	44
November 28	Bow Island	25
November 29	Medicine Hat	29
	Total	205

Total registered attendance was 1,006 people of whom 624 attended for themselves and 382 represented an organization or group. Of the total number of briefs presented, slightly more than half were personal (109) and the remainder (96) were from groups. (See Appendix 3.)

Source of Briefs		Number
Personal		109
Irrigation organizations		22
Local governments or agencies		20
Agricultural groups		16
Environmental groups		11
Chambers of Commerce		6
Industrial groups		6
Native groups		2
Political parties		1
Provincial governments (Saskatchewan)		1
Other		11
	Total	205
Supplementary Briefs		33
	Total	238

The Environment Council was impressed with the range of new ideas, information, and points of view presented at the Public Hearings. Particularly impressive was the number of people who chose to make presentations outside their local area. These presentations and subsequent discussions (both formal and informal) resulted in a broader understanding of the water management strategy being considered. This report summarizes and uses the ideas presented and develops many to the extent possible. Public Hearings improve resource decision making by broadening the ideas and information base. Furthermore, an aware and informed public increases the likelihood of quality decisions on future resource issues.

In addition to the public presentations, the Environment Council received 33 supplementary briefs many of which were in response to questions raised at the Hearings (see Appendix 3). The Council appreciates the extra effort made by those who took the time to provide additional information.

2. PRESENT WATER MANAGEMENT

2.1 DEVELOPMENT OF IRRIGATION

Although a few small irrigation schemes were undertaken in the 1880s, the history of irrigation in southern Alberta does not really begin until 1893 when a large tract of land was acquired by the Alberta Railway and Irrigation Company at Lethbridge. The irrigation scheme for that land, and later developments by the Canadian Pacific Railway, were part of the railway company's settlement plans to increase population and production and to generate railway traffic. By 1911, some 50,000 acres were under irrigation in Alberta.

In 1915, the Alberta government enacted the Irrigation Districts Act, which enabled farmers to organize into an irrigation district and to float bonds to raise capital to finance construction of the irrigation works. Irrigation districts expanded steadily until 1935 when about 190,000 acres were irrigated.

The Meek Report in 1942 recommended that Canada construct major river diversions on the St. Mary River system in order to protect Canada's share of these international waters. The result was an agreement in 1950 between Canada and Alberta to construct the St. Mary irrigation system which was completed in the following ten years. Meanwhile, in 1946 Alberta took over the Alberta Railway and Irrigation Company, which had been acquired by the CPR, and formed a crown corporation, the St. Mary and Milk River Development Company.

In 1963, co-operative interagency studies pursuant to the Agricultural Rehabilitation and Development Act (ARDA) identified rehabilitation needs of the districts and recipients of irrigation benefits. These studies indicated that the beneficiaries of irrigation were:

primary producer	11 per cent
local communities	22 per cent
Alberta	32 per cent
Canada	35 per cent

These studies also became part of the basis for the current cost-sharing formula. This formula assumes 86 per cent of the benefits of irrigation fall to the province and the remaining 14 per cent to the primary producer.

A uniform administration system for Alberta's organized irrigation areas occurred when the Irrigation Act (1970) was adopted. A major feature of this legislation was the creation of the Irrigation Council to guide the management of irrigation districts throughout Alberta.

In 1973, an agreement between Canada and Alberta transferred responsibility for all irrigation works in Alberta to the provincial government. This brought the Bow River and St. Mary Projects under direct provincial control in 1974 and resulted in the Phase I studies for the Oldman River Basin. A recent agreement with the Lethbridge Northern Irrigation District has brought all major Oldman River headworks (except United Irrigation District) under provincial control and has stimulated further interest in a water management program for the basin.

The first 50 years of irrigation development in Alberta irrigation was undertaken by private companies and irrigation farmers without government assistance. During this time, 200,000 acres in southern Alberta were developed. The federal government initiated the programs of massive government assistance, with the headworks on the St. Mary River. In 1973, the federal government withdrew its support and the provincial government stepped in, replaced the federal program, and extended government support. The Government of Alberta now provides 86 per cent of the district rehabilitation costs, in addition to total headworks costs. This increased government support has underwritten the remarkable post-war expansion of irrigation to the present 940,000 acres in Alberta (Alberta Agriculture 1978b).

2.2 ADMINISTRATION OF IRRIGATION

From the brief history above, it can be discerned that the southern Alberta irrigation farmer is assisted and influenced by many levels of administration. Those levels most significant to this study are the provincial government, the Irrigation Council, and the irrigation districts. Of lesser importance are the federal government, the International Joint Commission, the regional planning commissions, and the county or municipal district.

2.2.1 Provincial Government

Alberta Environment is responsible for the headwork systems of all irrigation districts in the basin except United and Ross Creek Districts. The St. Mary headwork system extends from Waterton Reservoir to the outlet of Milk River Ridge Reservoir. Headworks for the Lethbridge Northern extend from the Oldman River diversion to the outlet gates on Keho Lake. Operations are carried out either by the department's own staff (St. Mary) or through a contract arrangement with the districts (Lethbridge Northern). It is expected that the Aetna, Leavitt, and Mountain View headworks down to and including Paine Lake will remain under provincial jurisdiction. Authority to operate these systems arises from Section 49 of the Water Resources Act which gives Alberta Environment the status of an irrigation district under The Irrigation Act.

The 1977-78 operation and maintenance budget for the headwork systems was $848,600 with a manpower commitment of 46 man-years. Comparable 1978-79 projections are about $1 million with the same staffing.

Under the Water Resources Act, Alberta Environment has a major responsibility to regulate the consumption of water, including private or onstream irrigation schemes, a significant consideration in regional water management policies. The private irrigation activity in the South Saskatchewan River Basin is substantial as illustrated in Table 1. At January 8, 1979, the department estimated that projects in good standing required 103,859 acre feet of water from the Oldman River Basin to the junction of the Bow and Oldman Rivers. This approaches the near future estimates of the Management Committee and may mean the far future estimates of 192,000 acre feet of water for private irrigation will be reached sooner than anticipated, particularly as much of this irrigation is downstream of the Bow-Oldman junction (Acres 1978, Table C-3).

Table 1

Private Irrigation

Applications Received, Interim Licences Issued During the Calendar Years 1970 to 1978 and Licences Issued Under The Water Resources Act

		1970	1971	1972	1973	1974	1975	1976	1977	1978	Totals 1970 to 1978
Bow River Basin	Applications Received	3	1	3	11	12	22	17	22	14	105
	Interim Licences Issued	3	1	1	9	6	7	23	13	7	70
	Licences Issued	3	2	3	3	-	7	18	-	5	41
Red Deer River Basin	Applications Received	9	13	20	10	5	24	43	39	26	189
	Interim Licences Issued	17	22	15	19	3	16	20	25	48	185
	Licences Issued	12	22	16	15	-	11	13	5	21	115
Oldman River Basin	Applications Received	11	20	25	19	53	38	53	72	61	352
	Interim Licences Issued	15	25	22	22	26	34	38	40	36	258
	Licences Issued	28	23	26	20	6	32	33	6	27	201
All 3 Basins Total	Applications Received	23	34	48	40	70	84	113	133	101	646
	Interim Licences Issued	35	48	38	50	35	57	81	78	91	513
	Licences Issued	43	47	45	38	6	50	64	11	53	357

Based on information received from Alberta Environment.

Alberta Environment is also responsible for maintaining water quality (see Section 4.4) under the Clean Water Act.

The Irrigation Division of Alberta Agriculture provides professional and technical assistance to irrigation farmers through programs such as classifying soils, advising on salinity problems, investigating capital works projects, assisting in the design layout and selection of sprinkler systems, advising on rehabilitation, and reviewing new products. The department also assists the Irrigation Council (see Section 2.2.2) by staffing the Irrigation Secretariat. The resources of both Alberta Agriculture and Alberta Environment are available to the Irrigation Council in carrying out its responsibilities.

2.2.1.1 Provincial Funding for Irrigation

1. Between 1975 and 1985, Alberta Environment has available $110 million from the Heritage Savings Trust Fund for water management projects, $45 million for headworks rehabilitation and $65 million for water storage on the Oldman River system.
2. Alberta Agriculture has $40 million for rehabilitation work in existing irrigation districts and $50 million for expansion of irrigation districts by bringing new acreage under irrigation. These funds are combined in practice and are normally allotted to all irrigation districts in Alberta at the rate of $9 million a year for ten years beginning in 1975.
3. Alberta Agriculture has an additional $2 million for department irrigation rehabilitation programs. For practical purposes, the two programs are joined, so $11 million a year is currently available to all irrigation districts to pay for 86 per cent of the cost of rehabilitation of district works.

Alberta Environment operates a water management cost-sharing program. Under this program, a variety of water management activities can be shared with local authorities (including irrigation districts) at a rate related to the degree of public benefit obtained. Cost sharing under this program,* which is used mainly for drainage works, is generally 50/50. In northwestern Alberta where, in addition to drainage, erosion is a serious problem, the split is 75/25 (provincial/local).

An anomaly has developed between this program and the Irrigation Rehabilitation Program. Drainage is important to dryland and irrigation farming throughout Alberta. Irrigation drainage can be funded as part of an irrigation district's rehabilitation program and is eligible for the 86/14 (province/district) cost-sharing formula. In contrast, a dryland drainage problem is subject to the Financial Assistance for Water Management Policy and, consequently, the landowner (through his local government) pays more than 14 per cent. This anomaly in payment rate can be a source of local tension if it occurs near an irrigation district boundary.

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* Details of this program are available in *Cost Sharing of Water Management Projects,* Alberta Environment (1972b).

2.2.2 The Irrigation Council

The Irrigation Council was created in 1968 as an advisory board and adopted its present format in November 1975, pursuant to Section 4 (1) of the Irrigation Amendment Act. Seven members are appointed by Order in Council, one from each of Alberta Agriculture and Alberta Environment and the remainder on the recommendation of the Minister of Agriculture. The five other members are currently irrigation farmers who provide local and regional input and who are aware of the practical problems of irrigation. The Irrigation Council, which administers the Irrigation Act, receives administrative support from the Irrigation Secretariat staff of Alberta Agriculture and technical support from both Alberta Agriculture and Alberta Environment. The stated objectives of the Council are "to effect a sound irrigation policy for the province, to administer The Irrigation Act and to effectively administer any cost-sharing agreements between the province and the 13 operating districts for the rehabilitation and expansion of district works" (Alberta Agriculture 1978b, p.39). The Irrigation Council has the authority to:

1. approve a petition to add or delete land from an irrigation district, or to form a new district;
2. approve money by-laws, district rates, and budgets which relate to the costs of maintaining and operating irrigation works of the district, including replacement or rehabilitation;
3. approve detailed plans and projects funded under the 86/14 cost-sharing formula;
4. approve ditch rehabilitation plans (see Section 2.2.3.1);
5. revise the provincial irrigation land classification standards.

Although little reference was made to the Irrigation Council during the Hearings, its important role in irrigation policy implementation should be recognized. The provincial government has effectively transferred to the Irrigation Council much of the responsibility for developing irrigation, including detailed approval of programs and funding. Through approvals for ditch rehabilitation, the Irrigation Council establishes program priorities to control seepage and improve delivery efficiencies. Through land classification standards, the Irrigation Council indirectly, but effectively, controls new land to be irrigated.

The Irrigation Council is an innovative and effective solution to the problem of bureaucratic centralization. The government has transferred to it responsibility for the detailed implementation of plans and programs, budget supervision, and supervision of irrigation districts and, in doing so, has transferred decision-making power from civil servants back to practising irrigation farmers conversant with the detailed problems of irrigation. Unfortunately, the value of the Irrigation Council is not widely recognized. Hence, in order to establish a greater public awareness, the Environment Council recommends that the Irrigation Council prepare and publish an annual report. As indicated, the Environment Council is impressed both with the recent accomplishments of the Irrigation Council and with its potential.

2.2.3 Irrigation Districts

Irrigation districts, all of which operate under the authority of the Irrigation Act (1970), are managed by irrigator-elected boards of directors whose major function is to establish policies for the district. The number of directors is based upon acres on the assessment role of each district. District boards are currently accountable directly to the Irrigation Council for many activities, particularly where money by-laws are concerned. Several aspects of district operations were commented on during the Public Hearings.

2.2.3.1 Compensation for Seepage

Three briefs (20, 56, 71)[1] linked inadequate maintenance of canal systems with seepage problems, and raised the question of compensation for seepage damage. Although compensation for seepage damaged land is provided for under the Irrigation Act, attaining compensation is a very complex process.

a. Damage claims must be filed at a board office no later than November 1 of the year in which the damage occurs. However, as Stanley/SLN (1978) indicated, salinity problems can occur over wide areas and extended time periods. This can make the filing of claims on the yearly basis difficult, particularly when the onus of proof lies with the claimant (Irrigation Act, sec. 173).

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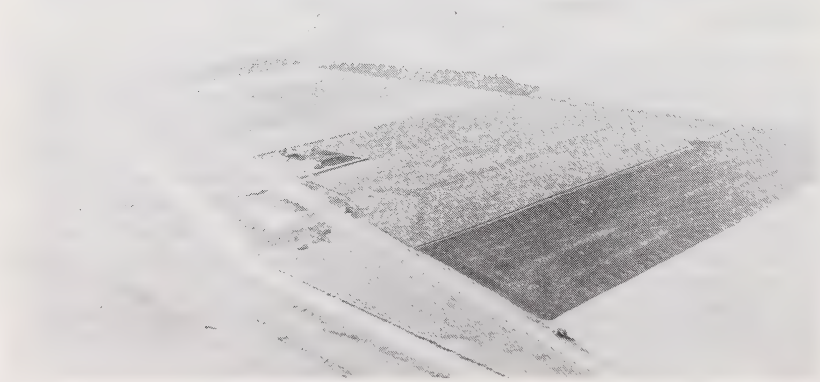
[1] All briefs are listed in Appendix 3 and numbered in order of presentation at the Public Hearings.



Dixon Thompson

Seepage occurs along many older irrigation canals.

b. The board of an irrigation district has the authority to designate an area as a "seepage damage area" and can apply to the Public Utilities Board to determine a fair market value for the damaged land. When such a request is filed, it halts any action for claim unless the irrigation district withdraws that application. When an order is issued by the Public Utilities Board, the irrigation district is directed to pay compensation. Subsequent registration of the order can be made against the title thereby prohibiting forever any future damage claims. The Irrigation Council has suggested that district boards are reluctant to designate "seepage damage areas" because of the long-term effect of putting that land out of permanent production (Irrigation Act, sec. 174, 175).

c. By having a "ditch rehabilitation plan" accepted by the Irrigation Council under the Irrigation Act, a district board can apply for a regulation which exempts it from the provisions outlined in *a* and *b* above. This plan describes the rehabilitation program for the district, the costs involved, and the expected duration of the project. If the Irrigation Council accepts the plan, it advises the Lieutenant Governor in Council, who by regulation exempts the board from paying compensation. Such exemption is effective at the date at which the plan is filed with the Council, not the date at which it is filed under the Regulation Act. To date, six ditch rehabilitation plans have been filed in the *Alberta Gazette.*

Alberta Regulation 207/73	
St. Mary River Irrigation District	Sep 23/71
Lethbridge Northern Irrigation District	Sep 21/71
Taber Irrigation District	May 25/73
Alberta Regulation 68/78	
Lethbridge Northern Headwork System	Jun 16/77
Waterton-St. Mary Headwork System	Jun 16/77
Alberta Regulation 471/79	
United Irrigation District	Apr 12/79

The ditch rehabilitation plans for the Lethbridge Northern and the Waterton-St. Mary headwork systems were filed by Alberta Environment. For these two works, Alberta Environment has become an irrigation district and is exempt from paying compensation for seepage or damage from the main canals and structures.

d. The Irrigation Act also contains a clause which may permit a district to be released forever from claims relating to seepage and overflow from its works if appropriate agreements have been made before May 2, 1968 (sec. 192).

This legislation makes it almost impossible for a landowner to claim compensation for seepage damage caused by a district or Alberta Environment. While the encouragement of ditch rehabilitation programs is laudable and there is no question that rehabilitation of the delivery system will reduce seepage and other water damage, the weighting of the liability process so heavily in favour of the districts may remove the urgency and incentive to treat seepage and associated salinization promptly and effectively.

Accepted rehabilitation plans are normally reviewed in the fall of each year to assess the progress being made. If progress is unsatisfactory and if that failure is not due to circumstances beyond the board's control, the Irrigation Council can file a report with the Lieutenant Governor in Council recommending that the exemption from compensation payment be removed.

The Environment Council appreciates that both the irrigation districts and Alberta Environment should be protected from unwarranted damage claims. However, the level of protection in this situation appears disproportionate. In this regard, the Environment Council must strongly remind the Irrigation Council of the weight of decisions made when a ditch rehabilitation plan is accepted. The balance struck between limiting the freedom from liability action and a long-term objective of rehabilitating present delivery systems reaches deeply into the structure of society. For this reason, both the irrigation districts and Alberta Environment have moral responsibilities beyond those described in the seepage sections of the Irrigation Act. The seepage sections of the Act must be administered in a manner consistent with these responsibilities, particularly for the dryland farmer who is neither in a position to influence irrigation administration nor to derive benefits from irrigation. When the rehabilitation program is complete, sections 178, 179, and 180 of the act should be repealed. In the meantime, irrigation districts and the Irrigation Council should receive and deal with damage claims with the utmost diligence.

2.2.3.2 Finances

A few Hearing participants (briefs 144, 200) commented directly upon financial operations of irrigation districts. The Environment Council has identified the following issues.

a. Water Rights

A district levies a one-time charge against new acreage "to be irrigated" as a contribution to works already constructed or to be constructed. If extra costs are involved to service the new acreage, a district may charge the landowner an additional fee. The Environment Council believes this to be a desirable approach and endorses it. Water rights (in dollars per acre) for the years 1968 to 1978 are shown in Table 2.

Table 2

Water Rights Payments
(current dollars per acre)

Irrigation District	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Aetna	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Bow River	10	10	10	10	10	10	10	10	10	10	20
Eastern	10	10	10	10	20	20	20	20	20	20	50
Leavitt	0	0	0	0	0	0	0	0	0	0	0
Lethbridge Northern	14	14	14	14	14	14	14	14	14	14	14
Magrath	0	0	0	0	0	0	0	0	0	0	20
Mountain View	0	0	0	0	0	0	0	0	0	0	0
Raymond	10	10	10	10	10	10	10	10	15	15	15
Ross Creek	0	0	0	0	0	0	0	0	0	0	0
St. Mary River	10	10	10	10	10	10	10	10	11	13	15
Taber	10	10	10	10	10	10	10	20	20	20	20
United	0	0	0	0	0	0	0	0	0	10	10
Western	0	0	0	0	0	0	0	0	0	5.00	7.50

b. Water Rates

An annual per acre service charge is levied against a landowner's acres on the assessment role to provide for the financial and administrative responsibilities of the district. Table 3 contains the range of rates from 1968 to 1978. All districts have increased their rates over this period to a weighted average of $5.00 per acre, based on assessment roles.

Anderson (1979) put Alberta's water rates into an international perspective. He noted a wide range of circumstances. For example:

1. No charge—Norway, Thailand, Egypt.
2. A charge to cover operation and maintenance of irrigation works—Argentina, Australia, France, New Zealand.
3. A charge to recover part of the capital cost plus the operating and maintenance costs—Israel, U.S.A., Mexico.

Other countries fall into the categories above and the factors considered in assessing the rates vary. There does, however, appear to be a pattern of subsidization of irrigation by the general public. In 1971 the United States had charges ranging from $0.85 to $57.96 (mean = $5.99 U.S.) per acre foot. Current figures undoubtedly have increased substantially.

c. Terminable Water Agreement

The board of an irrigation district can enter into an agreement with a landowner to provide water on the understanding that it can be terminated with appropriate notice (as defined in the Irrigation Act) by either party. The per acre rate charged for this water depends on decision dates and who makes the decision. The rates charged are usually very close to the normal water rates found on Table 3.

d. Water Benefit Charges

The Irrigation Act has a provision which enables a district to assess a charge on lands that they consider are benefiting from proximity to irrigation works. A judgement is made on the physical possibility of water being made available from the irrigation works for domestic purposes by the land's occupant or owner.

e. Irrigation Works Fund

Construction of new works and rehabilitation of existing works is financed through this fund. Irrigation districts do not use normal depreciation for their works, but the Works Fund does provide a mechanism for replacement or rehabilitation. Contributions to the Works Fund are at the discretion of a district.

Table 3

Irrigation District Annual Water Rates

(current dollars per acre)

Irrigation District	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Aetna	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.25	$1.25	$1.50	$1.50
Bow River	$2.50	$2.75	$3.00	$3.00	$3.00	$3.00	$3.00	$3.00	$3.50	$3.50	$4.00
Eastern	$2.60	$2.70	$2.70	$2.70	$2.70	$2.70	$3.00	$3.50	$3.85	$4.15	$4.25
Leavitt	$1.25	$1.25	$1.25	$1.25	$2.25	$2.25	$2.25	$2.25	$2.25	$3.25	$3.25
Lethbridge Northern	$2.70	$3.00	$3.00	$3.25	$3.50	$4.00	$5.00	$5.50	$6.00	$6.50	$7.00
Magrath	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$3.00	$3.50	$3.75	$4.00
Mountain View	$0.60	$0.60	$0.60	$0.60	$1.25	$1.25	$1.25	$1.25	$1.25	$1.75	$1.75
Raymond	$1.00	$1.25	$1.25	$1.50	$2.50	$2.50	$2.50	$3.00	$3.25	$4.25	$5.00
Ross Creek	$1.00	$1.00	$1.00	$1.00	$1.00	$1.50	$1.50	$2.00	$2.50	$2.50	$2.50
St. Mary River[1]	$2.30 $3.00	$2.30 $3.30	$2.30 $3.30	$2.30 $3.50	$2.50 $3.50	$2.50 $3.50	$4.00	$4.00	$4.50	$5.90	$6.00
Taber	$2.50	$3.00	$3.00	$3.00	$3.25	$3.25	$3.75	$4.50	$4.80	$5.00	$6.00
United	$1.15	$1.15	$1.25	$1.25	$1.25	$1.25	$1.50	$1.75	$2.00	$2.25	$2.50
Western[2]	$1.65 $2.00	$1.65 $2.00	$1.65 $2.00	$1.65 $2.00	$2.00 $2.50	$2.00 $2.50	$2.20 $3.00	$2.20 $3.00	$2.20 $3.00	$2.50 $3.40	$3.25

[1] St. Mary
- lower rate - West Division
- higher rate - East Division (1974 all acreage on roll charged the same rate)

[2] Western
- lower rate for major part of the district
- higher rate Gleichen subdivision (1978 all acreage on roll charged the same rate)

f. Domestic, Municipal, Industrial, and Excess Water

Irrigation districts sell water to many towns, villages, and some industries in the basin. Although it is not a large revenue source to the district, it is a necessary part of water management in southern Alberta. If excess water is available, it can be sold to any interested party.

g. District Land

Irrigation districts which own land may lease it for revenue. Even in the larger districts in the basin, the revenue is not large (generally less than $10,000 a year).

2.2.3.3 Re-allocation of Irrigation Rights

A few Hearing participants (briefs 92, 94) in the Lethbridge Northern Irrigation District (LNID) hold irrigation rights which they are interested in relinquishing. The Lethbridge Northern Irrigation District offered to remove the land from the assessment role, on a clear understanding that it would be a permanent transaction. On that basis, landowners were not prepared to accept removal. Permanent loss of irrigation rights is a serious matter and the reluctance of landowners is understandable. Equally understandable is the reluctance of an irrigation district to remove land from the assessment role after going to the expense of providing facilities or service to that land.

2.2.3.4 Other Irrigation District Activities

All larger irrigation districts are faced with the problem of responding to either an individual or a group of landowners who wish to proceed with rehabilitation at a rate faster than that proposed by the districts. While accelerated rehabilitation programs are beneficial to the district as a whole, it means that funds would need to be diverted from already established programs. The immediate benefits accrue to the landowner where the early rehabilitation takes place, and it is difficult to explain the rationale to another landowner who may find rehabilitation in his area being set back an additional period. All districts must deal with this problem and try to establish procedures to handle it. The Lethbridge Northern Irrigation District partially supports accelerated rehabilitation and will participate on a 50/50 basis, to a project maximum of $5,000, to rectify an individual farmer's canal problem immediately.

The Lethbridge Northern Irrigation District has two policies which relate to future water demands and potential for expansion:

1. To convert all terminable agreements to permanent irrigation agreements by 1981 (brief 193). The option to cancel delivery to the 20,216 acres reported in 1977 as terminable will then disappear. This option, however, has been more apparent than real since in the last water crisis, when water was shut off for 10 days in July and August 1977, permanent and terminable agreement holders were treated identically.

2. To allow an irrigation farmer up to a 10 per cent increase in his irrigated acreage in order to fill out an existing irrigated parcel. This is unlikely to result in a significant increase in water demand for the district.

2.2.4 Other Administrative Bodies

National agricultural policies, international marketing practices, and interprovincial transportation of agricultural products are the major involvement of the federal government, although taxation policy is also critical to the agricultural industry.

The International Joint Commission assists in the administration of the Boundary Waters Treaty of 1909. In a 1921 order under this treaty the "Governments of Canada and the United States agreed that the St. Mary and Milk Rivers and their tributaries in the State of Montana and the Provinces of Alberta and Saskatchewan are to be treated as one stream for the purposes of irrigation and power, and that their waters are to be apportioned equally between the two countries" (IJC 1977, p. 13).

Regional planning commissions were created by the Planning Act as a regional administrative agency with representation from all levels of local government. The planning commissions report to the Minister of Municipal Affairs through the Alberta Planning Board. Each planning commission is required to prepare a regional plan by December 31, 1982, after which time all land uses must be consistent with the ratified plan. The impact of regional land-use plans could be significant, depending on the precise designation in the land-use plan. For example, land designated for agricultural use which changes from dryland to irrigation farming would be consistent with the plan. However, land designated for dryland farming which shifted to irrigation farming would require an amendment to the plan, and ministerial ratification.

The counties are interested in irrigation largely because of potential recreation benefits (brief 153), concern about local water supplies (brief 167), and implications to roads (brief 153). There is also a significant financial interest as irrigated land is assessed at about 1.7 times that of dryland (brief 167).

3. THE STUDY AREA

3.1 PHYSICAL SETTING

The Study Area (Figure 1) encompasses those portions of southern Alberta drained by the Oldman River and by the South Saskatchewan River excluding the Bow and Red Deer River Basins. The landforms of the area change from rugged, mountainous terrain in the west, where elevations exceed 10,000 feet above sea level, through the foothills and western plains to the eastern plains at elevations of 2,000 to 3,000 feet above sea level. Except for the Porcupine Hills, Cypress Hills, and Milk River Ridge, local relief over most of the plains area is limited, usually to less than 100 to 125 feet, although the Oldman and South Saskatchewan Rivers are incised into this terrain more than 300 feet in some locations.

Soils of the region are formed mainly from glacial deposits, principally tills, and include three distinct soil regions. West of a line from Cardston through Brocket to Strathmore the soils are of the Black Soil Group. These soils favour the growth of a wide range of crops and their natural productivity is generally quite high. From there, east to a north-south line passing between Coaldale and Taber, the soils are of the Dark Brown Soil Group. Moisture is the main limiting factor in the productivity of these soils. The Brown Soils occur in the semi-arid, short-grass prairie region extending eastward to the border excluding the Cypress Hills and portions of the Milk River Ridge, which are in the Dark Brown Soils Group. Productivity on the Brown Soils is limited by a lack of moisture. Much of the region is not cultivated, but is used as native pasture. The Dark Brown and Brown Soils are, however, generally well suited to irrigation and approximately 90 per cent of the land currently irrigated in the study area is in these soil regions.

Southern Alberta generally has sufficiently high summer temperatures to grow most mid-latitude crops. The river basin, particularly the eastern portion, receives more hours of sunshine than any other part of Canada. Summers are long, hot, and dry. Degree-days (number of fahrenheit degrees above 42^{0}F multiplied by the number of days) exceed 2,700 in most of the central and eastern half of the basin, increasing eastward. The high temperatures allow many specialty crops to be grown under irrigation. An average of 120 frost-free days occur during the growing season in the plains with the first fall frost usually occurring after September 15. Localized conditions can cause wide departures in climate from those shown on the generalized map.

There is a marked decrease in mean, annual, growing season precipitation (April to August) as one proceeds from west to east through the Oldman River Basin. Along the western foothills and western edge of the plains, seasonal precipitation exceeds 11 or 12 inches and a wide range of crops can be grown. Moisture supply is variable and sometimes inadequate for high crop yields. Supplemental irrigation may be applied to crops to ensure high yields. In the central portion of the basin, rainfall averages 8 to 10 inches during the growing season, hence, irrigation is necessary to enhance crop yields. Rainfall decreases eastward, dropping to less than 8 inches mean, annual, growing season precipitation east of Grassy Lake. Irrigation is essential to ensure the growth of most crops in this area. Throughout the region, yearly precipitation is highly variable although the major precipitation peak usually occurs in June followed by a sharp drop in precipitation during July. Expansion of irrigation should occur where the soils and climate can be expected to give the greatest return for use of water. This is the region east of Lethbridge.

3.2 ENVIRONMENT

Environmental considerations within the basin range from a concern for the uniqueness of the ecosystems of the western end, through concern for the preservation of a largely man-created environment in the central portion of the basin, to primarily an interest in what can be done to enhance the environment for human habitation towards the eastern end of the system. The western end of the basin contains more diverse habitat types in comparison with the central and eastern regions. For example, in the west there is not only contrast between the grasslands above the river valley and the sheltered bottomland beside the river, but also a change from the mountains to the plains. Diversity in habitat types results in a greater number of plant and animal species per unit area. It also creates more varied opportunities for the recreationist (see Section 3.3).

The rich diversity in habitats diminishes as one moves eastward into an area of lower annual precipitation and higher heat units (Figure 1). There are fewer trees here, and fewer natural bodies of water. Only the river valley, the coulees, and the Cypress Hills provide natural topographic relief from the level to gently rolling terrain. Irrigation has played a major part in enhancing the central and eastern regions of the basin for human habitation. For example, without irrigation, Keho Park and golf course would not have been created. Henderson Lake and the trees in Lethbridge provide a welcome oasis, but would not exist if it were not for irrigation. Farmsteads have been created as a result of irrigation in this area, which in turn have provided pockets of suitable habitat for various wildlife species. Opportunities for recreation do exist, although they are largely man-created and not as varied as the opportunities available in the western end of the basin.

The Environment Council recommends that land owners be encouraged to maintain areas unsuitable for crops in a manner which would add to diversity and provide shelter for wildlife. This, added to shelter belts, often created with free seedlings from Alberta Agriculture, helps to maintain landscape diversity, which benefits a variety of wildlife and is aesthetically pleasing.

3.3 RECREATION

The recreational value of a region depends primarily upon the variety of opportunities available. Therefore, the more diverse the natural environment, the more valuable the resource becomes. Distance from the resource to both local and regional population centres is, of course, a major factor as well. However, with the advent of higher wages and increased leisure time, particularly in Alberta, people are better able to spend their free time and money in recreational pursuits and are willing to travel greater distances to utilize higher quality resources. As the population continues to increase, demand for these facilities will also grow.

High quality, water-based recreation is presently available above the Lethbridge Northern Irrigation District diversion in the western end of the Oldman River Basin in the Three Rivers area and further west into the foothills and mountains. The area above the diversion is the last wild river in central and southern Alberta. The Oldman River and the

Castle and Crowsnest Rivers flowing into it provide some very good canoeing (brief 97). Trout and mountain whitefish abound in the cold waters and provide the angler with many opportunities. Summer hikers wander beside the shores. Children and adults alike enjoy the water during a peaceful afternoon picnic on a hot summer's day. The graceful valley cottonwoods which provide shade for all thrive on the rich and moist bottomland soil, and depend upon the periodic inundation by floodwaters for their survival.

Access roads are few and far between, but according to information presented at the Hearings, most landholders, if asked directly, will allow access to the river. Those living in the western end of the basin have available a larger number of water-based recreation areas: the Oldman River and its main tributaries, many of the smaller streams which originate in the mountains, smaller bodies of water such as Beauvais Lake and Waterton Lakes within the national park. There is also variety in the type of recreation which occurs here. Residents may, if they wish, divide their time among the local stream, river, or park, or travel a little further afield into the mountains for other forms of activity. Waterton Lakes National Park is available for activities related to either the lakes or the mountains.

In the Fort Macleod to Taber region, the central portion of the Oldman River Basin, the picture changes. This region is no longer within the transition zone between the mountains and plains; therefore, there is less variety in topography here and fewer opportunities for recreational pursuits. Because the land is drier, the heat units higher and the natural tree cover minimal, both ponded and free-flowing water become more precious as a recreation resource the farther east one travels within the basin. Several individuals felt the recreation value of the Oldman River in the Fort Macleod area is high (briefs 24, 27, 29, 31, 33, 74, 207). Although local residents mentioned a preference for fishing near the town, from the briefs presented at the Hearings, there did not appear to be as much desire compared to the western end of the basin for gaining access to the river through private land. The Girl Guide camp on the river near the town is well used and is apparently considered to be an area of significance according to local naturalists. Residents in the vicinity of Keho Lake use the park and the golf course. Other bodies of water used for recreation in this part of the basin include Henderson Lake within the City of Lethbridge and Park Lake north of Lethbridge, both created as balancing reservoirs for irrigation.

Apparently the fluctuations in water levels at Park Lake have little effect on its use for recreation (brief 64). In fact, there is a great deal of recreation pressure on this facility and local residents feel the provincial government should develop the adjacent 300 areas it owns to relieve this strain (brief 64). Irrigation canals could provide some recreation benefits such as for fishing and bird watching. Just downstream from the St. Mary Reservoir trees have been planted and recreational facilities provided.

The eastern end of the basin, from Bow Island to Medicine Hat, has even fewer water-based recreation resources by comparison with the central area. Regional facilities would include Cypress Hills Provincial Park for day trips, but there are few local facilities. There is the South Saskatchewan River, of course, for canoeing, motor boating, and fishing.

Residents at the western end of the basin do not want to see developments occur within the Oldman River Basin which would reduce the recreational value of the region. They have what can be rightly termed high quality recreation now. An onstream storage reservoir, for example, would do nothing to enhance this resource, but would do a great deal to diminish its value. Creation of a reservoir here would cover the bottomland and in its place would be a large, open body of water possibly unsafe for boating because of the strong prevailing winds, and unsightly during the late summer and autumn months because of the exposure of extensive mudflats following drawdown. Water temperatures in the shoreline regions of a reservoir may be higher than in the original stream. Hence, if warm water fish species are trapped upstream of the dam site they can survive in these areas. This means warm water fish may be found further upstream after a dam is built, to the possible detriment of the cold water fishery.

In the central portion of the basin, residents spoke against any expansion which would destroy the few water-based recreation facilities they have. Examples would be the park and golf course at Keho Lake. Further development of the government-owned land at Park Lake is considered desirable by local residents (brief 64) and primarily positive comments were heard for development of the recreation potential at Stafford Lake (briefs 15, 81, 160).

Residents in the eastern end of the basin expressed the need for small, permanent bodies of water with stable levels and shade trees where park and picnic facilities could be established. Yellow Lake contains a substantial pike fishery and was mentioned as a possible site.

The Management Committee made a number of recommendations in its report (pp. 63-64) upon which the Environment Council wishes to comment. First, the Council recognizes that there are administrative problems in co-ordinating the planning, funding, and management of recreational facilities in the Oldman River Basin. The Council is opposed to the Management Committee recommendation that an advisory committee be set up for this purpose, primarily because of the large number of government departments involved. Instead, the Council recommends that the Oldman River Regional Planning Commission and the Southeastern Alberta Regional Planning Commission create regional recreational plans. Technical subcommittees are an appropriate mechanism for creating these plans. The Environment Council expects the Planning Commissions will involve both the public and appropriate government departments and irrigation districts as required.

The Environment Council agrees with the Management Committee recommendation that existing and proposed storage facilities in the basin be operated with a minimum flow criteria of 360 cubic feet per second as measured at Lethbridge (p. 63). The Council has recommended that minimum flows in the St. Mary, Belly, and Waterton Rivers not fall below 30 cfs. In contrast the Management Committee recommended flows in the far future not fall below 97, 33 and 80 cfs for these rivers respectively (see Section 4.3.3.)

Dixon Thompson

An aerial view of an irrigation operation showing three circles irrigated by centre pivot systems.

A centre pivot irrigation system.

Alberta Photographic Services

The Council disagrees with the recommendation of the Management Committee to stock large storage facilities with fish on an annual basis for improvement of local recreational angling. Stocking large reservoirs is not only expensive for the amount of recreation produced, but may often be a waste of money as existing reservoir fish will often outcompete the hatchery fish for food and space resulting in a high mortality of the introduced fish.

The Council agrees that before any additional reservoirs are constructed, detailed studies should be undertaken to determine the special considerations to be incorporated into design, development, and management of reservoirs for enhancement of fishery potential. The Council does not agree with the recommendation that Alberta Environment should retain the services of a qualified reservoir limnologist to give advice on how the fishery potential might be improved. There are already qualified personnel within the Fish and Wildlife Division; therefore, hiring someone specifically to study reservoirs in southern Alberta is unnecessary.

Enlarging Keho Reservoir will have a substantial impact on the adjacent park and golf course. Several people expressed concern over the loss of an important water-based recreation resource and source of shade in an area deficient in tree cover. The Keho Park Golf Course has taken 15 to 20 years to develop to its present condition (brief 60). Raising Keho Lake would remove over one-third of the golf course and flood the clubhouse. The spokesman for the club stated that the portion of the course left above water could not, by itself, be adjusted to permit continued use of the golf course. He does not feel that diking is the answer because the present lake boundary is within four to five feet of the golf course and has been covered with rocks and boulders already to overcome the problem of bank erosion.

The Environment Council agrees with the Management Committee that the park facilities should be replaced, preferably to provincial park standards. Particular emphasis should be given to replanting the existing shade trees or replacing them with trees of equal size. In addition, compensatory land should be found convenient to the existing golf course and developed to the condition of the present course.

The Council agrees with the numerous Hearing participants who felt that water-based recreation can be planned into the developments in the basin, particularly at Forty Mile Coulee and Stafford Lake. However, the Environment Council lacks adequate information to make detailed recommendations. Hence, the Council recommends that the regional planning commissions review the matter during the creation of regional recreational plans. Regardless, provincial funding for the required recreational facilities should be generous.

4. ELEMENTS OF WATER MANAGEMENT IN THE OLDMAN RIVER BASIN

4.1 IRRIGABLE LAND AND SOIL CLASSIFICATION

The Management Committee (p. 35) received several estimates of the irrigable acreage within the Oldman River Basin (see Appendix 4). Based on general growth trends and a review of land which is classed as irrigable or appears productive and is within one mile of existing works, Underwood McLellan estimated that 747,000 acres could be irrigated in the near future and 1,044,000 acres irrigated in the far future. These levels of development, however, did not consider the availability of water.

Alberta Agriculture indicated similar levels of development were possible; 793,000 acres by 1995 and 1,018,000 acres by 2005. Again, this did not consider the availability of water.

Stanley/SLN (1978) estimated that 720,000 acres in the basin could be irrigated, but included only areas felt to be permanently irrigable without artificial drainage.

In its deliberations, the Management Committee (p. 58) concluded that development should progress to 650,000 acres by 1985, 750,000 acres by 1990 and 850,000 acres by 2005 (all figures include private irrigation). The availability of an assured water supply, not the availability of irrigable land, limits the ultimate level of development.

The difference in estimates provided by Underwood McLellan, Alberta Agriculture, and Stanley/SLN results from differences in soil classifications used. Stanley/SLN placed considerable emphasis on the natural drainability of the soils and suggested that Alberta Soil Classification Standards are not adequate in this respect. It suggests that only Class I and II soils should be considered irrigable, although "available low cost drainage technology may make permanent irrigation feasible on some of the marginal lands. Proper detailed land classification and drainage surveys may show conditions to be more favourable than is now judged" (Stanley/SLN 1978, Sec. 3, p. 12).

In its report, the Management Committee recognized the conflicting points of view and made two recommendations related to soil classification:

1. "Suitable irrigation land classification standards, which take into account regional climate variations, must be established and strictly enforced by the Irrigation Council. Alberta Agriculture, in cooperation with the irrigation districts, should produce maps that indicate 'acres to be irrigated'.
2. The Irrigation Council must be given sufficient government direction, authority, and resource to fully discharge its responsibilities under the Irrigation Act, particularly with respect to irrigable land classification, soil drainage, and the control of irrigation expansion by adjacent irrigation districts" (p. 60).

During the Public Hearings, land classification was commented on in several briefs (2, 58, 70, 71, 74, 98, 144, 185, 189, 193). These briefs stressed the importance of an adequate soil classification system, applied in an unbiased fashion, before a decision to irrigate is made. Brief 2 stated that the irrigation districts should have more responsibility for control of irrigation on unsuitable land and brief 71 said that some land had been classified incorrectly. The brief of the Eastern Irrigation District (189) suggested that the Soils Classification Standards should be flexible, not rigid, since the success of irrigation depends on the management skills of the irrigator, as well as the soil classification. The Eastern Irrigation District also supported 850,000 acres as being a realistic estimate of irrigation potential in the Oldman River Basin.

Several briefs suggested that in determining land to be irrigated, the classification system must go beyond a consideration of only the soil type to include climate, precipitation, farming efficiencies, cropping patterns, markets, heat units, and an evaluation of the economic productivity of the land (briefs 58, 144, 193). Whatever factors are included, the classification should be fairly and uniformly adopted (briefs 70, 98). The Oldman River Regional Planning Commission (brief 74) and the Red Deer River Regional Planning Commission (brief 185) both expressed the desire to be involved in establishing and enforcing irrigation land classification standards.

The Environment Council discussed the question of availability of irrigable land with Alberta Agriculture, members of the Soils Classification Committee, the Irrigation Council, and Stanley/SLN. The Irrigation Council sets minimum soil standards for irrigation, but these can be upgraded by irrigation districts. Alberta Agriculture staff commented that it is difficult to obtain an accurate soil classification for southern Alberta without considerable field work since few quarter sections fall uniformly within a single land classification. As a result, accurate land classifications have been completed for only a small area. The staff also repeated the comment that more information was needed concerning the natural, internal drainability of soils and its effect on the irrigability of an area. For similar reasons, Stanley/SLN prefers a conservative estimate of irrigable land and commented that, in Alberta, the government departments were reluctant to declare land non-irrigable, and even where this did occur the classification had little legal status.

Members of the Soils Classification Committee, referring to the concerns of Stanley/SLN about the drainability standards, commented that some drainage of irrigated land is necessary at some point to control salinization. However, in the opinion of the Committee, United States drainage standards that Stanley/SLN feels should be applied to Alberta soils, are too stringent under most circumstances. There are many differences between irrigation systems in Alberta and those in the United States. They noted the following:

a. uplands are being irrigated, not valleys as in most U.S. cases;
b. the irrigation season is shorter;
c. there is a longer drainage period between irrigation seasons;
d. the fractured nature of the till provides better vertical drainage than soil classifications indicate;
e. there is less evaporation on irrigated land in Alberta and, therefore, slower salt accumulation; and
f. the irrigation water is much lower in dissolved salts, therefore, salt accumulation is much slower.

The Environment Council believes that because of different geology, climate, and irrigation practices, the classifications standards used by the U.S. Bureau of Reclamation are not applicable to southern Alberta. The Alberta Soils Classification Committee should continue to improve the existing Classification Standards, taking into account the saline nature of southern Alberta's soils, and providing sufficient allowance for drainability to allow permanent irrigation. Research into the drainage characteristics of the glacial till of southern Alberta should be continued.

The Environment Council feels that assured water supply and development costs, not the availability of irrigable land, will be the factors that limit irrigation development in the Oldman River Basin. The available water, therefore, must be used in the most beneficial manner. Soils need to be classified and water applied in the most appropriate areas to ensure sound economic development. Well-managed irrigation of Class I and II soils pays added dividends in minimizing salinization problems and drainage needs. An irrigability classification system is required that incorporates not only soil type but heat units, precipitation, and other factors which affect economic productivity under irrigation.

Such a classification system should be developed by Alberta Agriculture and administered and enforced by the Irrigation Council. Within this classification system, the Irrigation Council should develop a priority listing of acres to be irrigated. The priority listing should also consider the willingness of area farmers to pay their portion of the proposed development costs and should be updated as new information becomes available (see Section 8).

4.1.1 Geographical Areas within the Basin

The Management Committee did not make specific suggestions regarding the ultimate level of development north and south of the Oldman River, other than to say that expansion is most favourable in the eastern part of the basin. It did say, however, that irrigation acreage should be increased through intensification, extension and private irrigation, before expansion into new areas. Many briefs presented at the Hearings addressed the topic of increasing irrigation acreage and most supported the Management Committee's approach of intensification and extension followed by expansion. Commenting specifically upon expansion, many briefs stated that, since water is becoming scarce, preference should be given to use the more productive soil and in areas which benefit most from irrigation (6, 7, 76, 84, 93, 94, 125, 144, 158, 160, 163, 179, 181, 201, 203). Many briefs specifically objected to the amount of irrigation allocated in the Water Balance Model (Acres 1978) to the area north of the Oldman River (6, 84, 88, 94, 99, 114, 144, 213). According to this model, the far future water supply alternatives selected by the Management Committee with onstream storage at Three Rivers will allow irrigation of 929,000 acres. Onstream storage at Brocket would irrigate 15,000 fewer acres. However, the Management Committee view is "Based on the potentially available water supply, the irrigation of 850,000 acres would be considered to be the ultimate level of irrigation development in the Oldman River Basin" (p. 58).

The Environment Council determined ranges for increasing irrigated acreage. These ranges north and south of the Oldman River are:

North	28,500 to 57,000 acres
South	100,750 to 207,500 acres

These are considered to be the acreages which can be developed at costs which will yield a reasonable economic return. They include additional acres on already serviced parcels, areas within the districts requiring minor development of delivery systems and some areas thought to be capable of being developed at low cost adjacent to the districts. Details are shown in Appendix 4.

North of the river, the Environment Council feels irrigation could increase from the present 110,000 acres to between 138,500 and 167,000 acres. According to information obtained from the Water Balance Model, water could be supplied to more than 200,000 acres. The question is whether there is sufficient suitable land which can be served economically north of the river to warrant utilizing the remaining water (see Section 8).

South of the river the St. Mary Project presently irrigates 383,600, acres but between 484,350 and 591,100 acres could be developed for irrigation according to existing estimates. The projected water supply could limit development to approximately 495,000 acres. Section 7 discusses utilization of this water south of the river.

Two sources provide general information concerning land capabilities north and south of the Oldman River: the report of Alberta Agriculture (1978a), Irrigation Division on expansion priorities and the Stanley/SLN (1978) report. These reports rate the probable major new development areas on a number of factors including soils, topography, and climate. North of the Oldman River, the areas rated were: Albion Ridge, Barons, West Barons, South Keho, and the Summerview Project. Nineteen areas south of the Oldman River were also rated.

In the report of the Irrigation Division, areas north of the river rated between twelfth and twenty-first on the basis of soils, between fifteenth and twenty-fifth on topography and between twelfth and twenty-fifth on climate. In all cases, areas south of the river rated above areas to the north (Appendix 5).

For the same area, Stanley/SLN provided a soils rating which considered only the amount of Class I and II soils. The areas were given a rating of 1 to 3; areas rated 1 were considered of higher priority for future development. Under this system, the projects north of the river received a rating of 2 or 3, placing them below eleven areas south of the river, which received soil ratings of 1.

Although these ratings should only be taken as guidelines, they do provide an indication that there are several areas south of the Oldman River that, based on land capability, rate much more favourably than areas north of the river. For example, among these areas, Chin East, West Forty Mile, and Horsefly North together include 137,000 possible new irrigable acres. An abundance of irrigable land is available south of the river which could effectively use the water allocated for the north side of the river, in the Water Balance Model, if water delivery were possible. (See Sections 7 and 8.)

Some districts have taken tentative steps towards over-allocation of water rights to make the most efficient use of the water surpluses available in some years. The districts may want to move further in this direction to avoid the increasingly high costs of guaranteeing a water supply as the use approaches the average annual available flow. Over-allocation has associated with it a high risk (variability of yield) which can be offset by reduced water costs or insurance programs.

Farmers must consider the risk when investing in irrigation equipment and in deciding on irrigation patterns. The use of "non-assured" flows will be beneficial only in certain areas and with certain crops. Discussions and decisions are required at the district level to determine methods of managing shortages, sharing risk, and allocating priorities. The tendency to consider the allocation of surplus water as a right rather than an approach to optimum utilization of the resource must be avoided. Other uses, particularly instream uses, must be assured before allocation of surplus flows.

4.2 FLOWS

The Oldman River Basin has a drainage area of 9,200 square miles in Alberta. The Crowsnest and Castle Rivers and the upper reaches of the Oldman River together contribute about 40 per cent of the Oldman River flow. The Belly River and its tributary, the Waterton River, contribute about 35 per cent and the St. Mary River the remaining 25 per cent. The flow of the Oldman River and its tributaries is highly variable. Generally, the natural flow is most abundant in May, June, and July and gradually decreases through August, September, and October. Lowest flows occur most frequently in January and February. The following material extracted from the report of the Management Committee illustrates the flow volumes and their variability.

Above Fort Macleod, near where the Lethbridge Northern Irrigation District diverts water from the river, the computed mean annual volume of natural flow is in excess of 1.1 million acre feet, ranging from a high of in excess of 2.3 million acre feet in 1951 to a low of 354,000 acre feet in 1944. During the average year over 60 per cent of the annual volume of flow occurs during the months of May and June. Monthly natural flows during the summer period have ranged from 934,000 acre feet to less than 17,900 acre feet. The Belly River, downstream from the confluence with the Waterton River, has a natural annual flow of about 898,000 acre feet, ranging from a high of 1,832,000 acre feet in 1951 to a low of 446,000 acre feet in 1944. About 70 per cent of the natural flow of the Belly River is contributed by the Waterton River.

Monthly natural flows in the Belly River above its confluence with the Waterton River have ranged from 179,000 acre feet in June to less than 1,790 acre feet in January. Flows on the Waterton River have ranged from a June high of 404,600 acre feet to a low in January and February of 2,975 acre feet. The St. Mary River has a mean annual natural flow of about 760,000 acre feet, ranging from a high of 1,380,000 acre feet in 1951 to a low of 370,000 acre feet in 1944. Monthly natural flows range from over 446,000 acre feet in June to lows of less than 1,790 acre feet in November. The Oldman River at Lethbridge, downstream from its confluence with the Belly and St. Mary Rivers, has a mean annual natural flow of about 2.9 million acre feet, ranging from 5.9 million acre feet in 1951 to 1.2 million acre feet in 1944.

The mean annual natural flow of the South Saskatchewan River at the point of apportionment is 7.6 million acre feet—2.9 million acre feet from the Oldman River, 3.1 million acre feet from the Bow River and 1.6 million acre feet from the Red Deer River.

4.3 WATER ALLOCATION

The supply of water has had and will have a major influence on development in southern Alberta. The Oldman River and its tributaries are the major source of water for the region, however, not all of the water from the system is available for use by Alberta. By national and international agreements, a portion of the flow must be available for use by Saskatchewan and by the United States. The consumptive use of water is licensed in priority to domestic, municipal, agricultural, industrial, water power (energy generation), and other users within the basin. The supply of water to these uses relative to their future needs will affect the location and rate of development within the region.

4.3.1 Apportionment

4.3.1.1 Alberta/Saskatchewan

Present

On October 30, 1969, Alberta, Saskatchewan, Manitoba, and Canada signed the Master Agreement on Apportionment, to be administered by the Prairie Provinces Water Board. Under the terms of the agreement, Alberta is entitled to consume, divert, or store a minimum of 2.1 million acre feet net depletion out of the flow of the South Saskatchewan River, measured downstream of the confluence of the Red Deer and South Saskatchewan Rivers, providing the actual flow is not at any time reduced to less than 1,500 cfs (cubic feet per second). Should the actual flow of the South Saskatchewan River fall below 1,500 cfs, Alberta is entitled to a quantity of water equal to a net depletion of one-half the natural flow of the river. The total diversion is accounted for on a yearly basis.

Future

A brief (180) presented by a representative of the Saskatchewan Department of Environment expressed concern that inadequate consideration had been given to the possibility of a change in the accounting period within the Apportionment Agreement. A change in the accounting period to a more frequent basis would be more restrictive than the present annual accounting period which allows higher spring flows to be balanced against short falls encountered during low flow periods.

The Prairie Provinces Water Board is conducting an ongoing study, one of the objectives of which is to review the effects of annual, quarterly, and monthly accounting. It was suggested in the Saskatchewan brief that Alberta, in its water management considerations, not rule out the possibility of change.

The Federation of Alberta Naturalists (brief 6) also expressed concern that changes from the present annual accounting would mean a reduction in the allowable diversion during low flow periods and, therefore, would reduce the potential for irrigation expansion within the Oldman River system. Brief 174 pointed out that the limits of the agreement have been approached in the past. The likelihood of shortfalls would increase with a shorter accounting period and, therefore, further water storage would be required.

Alberta Environment suggested that, due to the restrictions a shorter accounting period would place on water use within southern Alberta, Alberta as a member of the Prairie Provinces Water Board would likely take a firm stand opposing any change. Further, the presence of approximately 7.6 million acre feet of storage capacity in Lake Diefenbaker essentially eliminates the need for a reduced accounting period since there are few present or projected benefits from improved flows in the short distance between the Alberta border and Lake Diefenbaker.

Consequently, it is strongly recommended that the accounting period for the Apportionment Agreement remain on the present annual basis.

4.3.1.2 Within the South Saskatchewan River Basin of Alberta

Present

At present, no policy outlines the expected contribution to the agreement on apportionment of flows from each of the sub-basins (Red Deer, Bow, and Oldman) within the South Saskatchewan River Basin.

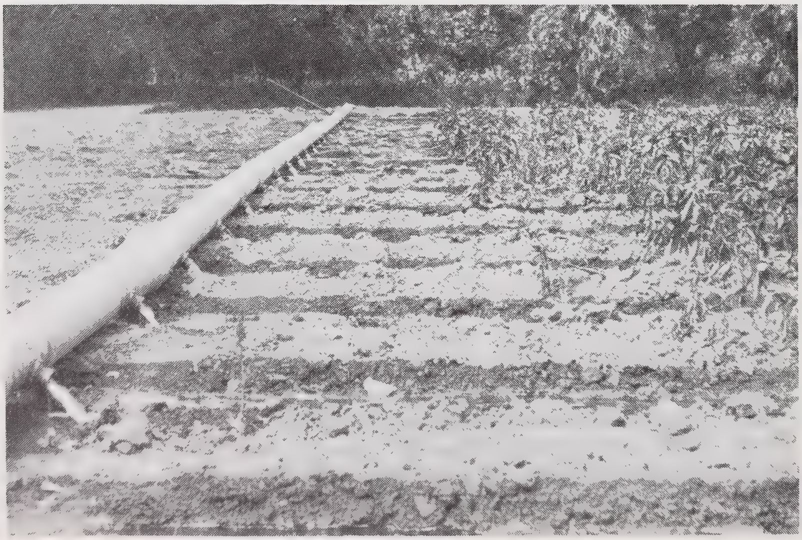
Future

The Management Committee did not make a specific recommendation concerning allocation to apportionment of flows from each sub-basin within the South Saskatchewan River Basin. In selecting the most suitable far future water supply alternatives, however, they assumed that the Red Deer River would contribute 75 per cent of its flow and the Bow River 50 per cent. The basis for management decisions relating to flows of the Bow, Red Deer, and Oldman Rivers will be provided by the South Saskatchewan River Basin Planning Program. This program, which will contain recommendations concerning the use and development of the water resources of the South Saskatchewan River Basin, will make information available by 1985.

Several briefs (10, 50, 82, 88, 177, 184, 185, 189, 194, 200) expressed concern over the suggested allocation of water between the Red Deer, Bow, and Oldman Rivers. Many briefs (6, 13, 74, 88, 98, 110, 177, 179, 180, 185, 189, 197, 200, 215) called for completion of water management studies on the South Saskatchewan River before decisions were made related to the Oldman River Basin, particularly in connection with onstream storage. Few briefs, however, seem to have considered in depth the implications, to the Bow and Red Deer Basins, of the assumptions made by the Management Committee. Even representatives from irrigation districts within the Bow River system had given little consideration to the implications.

One person (brief 10) said that he had assumed that the Bow River would get only 50 per cent of its flow and had adjusted his expectations to this. Another (brief 50) said that little thought had been given to the impact of altering the allocation of flows. Another brief (184) questioned whether people in the Bow River Basin would be content with receiving only 50 per cent of the flow and whether residents in the Red Deer Basin were convinced, as was the Management Committee, that there is no potential for irrigation development in that basin.

The City of Medicine Hat (brief 177) expressed concern about water availability if the consumption of the water from the Oldman River increased and was offset to the Apportionment Agreement by utilizing flows from the Red Deer River. The City stated that the water utility and power plant required minimum flows of 1,200 cfs to operate and that the Canadian Fertilizer Industry plant has a water licence under which the plant can be ordered to cease pumping if the flow in the South Saskatchewan River at Medicine Hat drops below 1,500 cfs. In 1977, the measured flow at Medicine Hat dropped to 462 cfs on April 30, (Environment Canada 1978), when all the flow possible was being diverted into the irrigation districts. There are implications to other onstream users as well, if the instream flows on the Oldman River are reduced and apportionment is met by utilizing the contribution of the Red Deer River.



Alberta Photographic Services

Flood irrigation done with a piped delivery system.

The Red Deer Regional Planning Commission (brief 185) wanted the South Saskatchewan River Basin study done immediately and a statement of government policy developed regarding water allocations within the South Saskatchewan River Basin. The Planning Commission argued that the change in flow allocation was an indirect form of interbasin transfer and that they would oppose the Red Deer River contributing more than 50 per cent of its flow to Saskatchewan, if this implied a limit to future growth or if additional water could not be obtained in the future through interbasin transfer from northern Alberta. The Eastern Irrigation District (brief 189) suggested that if the Red Deer River was going to contribute more than 50 per cent of its flow to apportionment, the Bow River Basin as well as the Oldman River should receive benefits from this allocation of flow.

The Water Balance Model gave some information about altering allocations between the rivers of the South Saskatchewan River Basin. The Management Committee report shows that the model predicted that the near future level of irrigation development, 677,000 acres in irrigation districts and 86,000 acres of private irrigation (p. 26), and flows at Lethbridge of 360 cfs (p. 63), could be satisfied whether the Bow and Red Deer Rivers were assumed to withdraw water according to the predicted 1985 demands, or according to the more stringent 50/75 (Bow/Red Deer Rivers) contribution criteria

If the allocation was set at 50 per cent of the flow from each sub-basin, the limit to irrigation development would be 693,000 acres (including private irrigators). Storage facilities would still be required at Keho Lake, Mud Lake, and Forty Mile Coulee to support the 607,000 acres of irrigation within irrigation districts. This is a district increase from the present of only 91,000 acres at a cost of $66 million (1978 dollars) for water storage facilities alone. If development proceeded, as indicated, expanding by 204,000 acres to 763,000 acres in the near future, without efficiency changes, and if it was later decided that the Red Deer River would contribute less than 75 per cent of its flow to Saskatchewan, additional water storage through construction of an onstream dam would be required to support that acreage.

The near future contribution to apportionment by the Red Deer River could, according to available information, exceed 75 per cent of its flow. The Management Committee (p. 21) states that at the assumed 1985 level of industrial and municipal development within the basin the Red Deer River could contribute 97 per cent of its natural flow in a wet year and 86 per cent of its natural flow in a dry year. The Red Deer River Flow Regulation Planning Studies (Alberta Environment 1975, v. 1, p. 21) estimate that municipal and industrial water consumption from the Red Deer River, assuming a maximum expansion trend, will total 105.4 cfs (76,306 acre feet per year) by 1984. Based on information from Alberta Environment, Water Licensing Branch, 509 private irrigation projects in the Red Deer River Basin presently utilize 49,293 acre feet of water. However, even if combined with approximately 76,000 acre feet annually of industrial and municipal withdrawals, consumption through to the year 1985 will be well below 25 per cent of the average annual natural flow of 1.6 million acre feet per year.

A report by Karkanis (1975) indicates that there is substantial irrigable area within the Red Deer River Basin. An examination of this report suggests that some of this land could be irrigated with water from the Bow River. Some areas would likely not be irrigated because of the difficulty of getting water to the block of land or because water could be delivered, but would be uneconomical. Other areas with suitable soils would benefit from only supplemental irrigation and, therefore, are unlikely to be economic to develop. It is considered unlikely that any major irrigation development will occur in the Red Deer River Basin due to the reasonable success of dryland farming or the high capital cost of developing irrigation, or both. Alternatively, there may be areas within the Bow River Basin which, because of climatic productivity, and economic advantages, should have priority over development in the Red Deer River Basin.

A study by Alberta Environment (1977a) indicated that the irrigated acreage in irrigation districts served with water from the Bow River could increase to about 550,000 acres by 1985 and would require an annual depletion of over one-half the Bow River's flow entitlement in a low flow year. Any increase in the irrigation acreage in irrigation districts served from the Bow River would, therefore, require measures to increase or to manage better the available water supply in the Bow River Basin. Any significant increases in water use from the Oldman River could place limitations on the potential for increasing the irrigated acreage served from the Bow River system.

Three main points arising from these comments should be emphasized:

1. development in the Red Deer River Basin is unlikely to be hampered in the near future by allocation of 75 per cent of its flow to the Apportionment Agreement;
2. development in the Bow River Basin could be restricted as early as 1985 if development proceeds as indicated in the Alberta Environment (1977a) report and consumption is limited to 50 per cent of the natural flow;
3. unless the Oldman River's share of flow to the Apportionment Agreement is met by a greater than 50 per cent flow from the Red Deer River, the cost of storage to allow expansion in the basin would be too high to provide an economically feasible system.

These three points emphasize the urgency of the South Saskatchewan River Basin Planning Studies. They also illustrate the inter-dependency of action within the three sub-basins, especially with respect to flow allocation and its implication for future development.

Although the Environment Council has had to make assumptions concerning future flow allocations, these assumptions have been made based on limited knowledge of the development potential or aspirations of the Bow and Red Deer River regions. The Environment Council considers that in order to provide a properly integrated plan for the South Saskatchewan River Basin, completion of the South Saskatchewan River study is urgent, and is much more pressing than indicated in the Management Committee report. This plan needs to be completed in order not to prejudge development in one sub-basin by activities already underway in another. The public also requires an opportunity to comment on these important matters through Public Hearings throughout the South Saskatchewan River Basin.

The Environment Council believes that the South Saskatchewan Planning Program should proceed as quickly as possible, in order that a comprehensive basin plan can be completed, commented upon, and accepted before developments in the Oldman River Basin restrict planning alternatives in the other sub-basins.

For planning purposes, the Environment Council has assumed that 75 per cent of the flow of the Red Deer River and 50 per cent of the Bow River will be allocated to meeting the Master Agreement on Apportionment. A change in the assumption does not affect the validity of the Council's major recommendations, although a smaller flow would reduce the irrigation potential and reduce the extent of benefits to be gained from the recommended water storage facilities.

4.3.1.3 United States

Present

The flow of international rivers is apportioned at the international boundary between Canada and the United States under the Boundaries Water Treaty of 1909. Apportionment of the St. Mary River is under a 1921 Order of the International Joint Commission. The main conditions of the agreement are:

a. during the irrigation season (April 1 to October 31, inclusive) when the natural flow of the St. Mary River at the international boundary is 666 cubic feet per second (cfs) or less, Canada shall be entitled to three-fourths and the U.S. to one-fourth of the flow.

b. during the irrigation season (April 1 to October 31, inclusive) when the natural flow of the St. Mary River at the international boundary is more than 666 cfs, Canada shall be entitled to a prior apportionment of 500 cfs, and the excess over 666 cfs shall be divided equally between the two countries.

c. during the non-irrigation season (November 1 to May 31, inclusive) the natural flow of the St. Mary River at the international boundary shall be divided equally between the two countries. The division of flow is balanced over a 15 day period and deficits in one period are normally made up during the immediate following period.

Future

In the Water Balance Model (Acres 1978), the United States was assumed to use its entitlement.

4.3.2 Municipal and Industrial Water Use

Present

Underwood McLellan (1978c) estimated the 1977 municipal and industrial water use within the study area. Municipal estimates were based on records of total consumption, where available, or were based on comparison with similar communities. Sources of water supply for the communities included surface and groundwater. The review considered all communities with a population of 100 or more, including those municipalities which receive their water via the irrigation system. In 1977, domestic, institutional, commercial, and recreational users within these communities consumed approximately 30,000 acre feet of water (p. 12). In addition, an estimated 15,000 acre (p. B-45) feet of water are withdrawn from wells and dugouts for rural domestic uses such as livestock watering and household use. A review of the large industrial water users in the study area indicated a total use in 1977 of 12,920 acre feet (p. B-38). This included all industries with an annual consumption in the order of 3.7 acre feet (1 million gallons) or more as well as those industries with modest requirements which received their water through a municipal system.

Future

Municipal, industrial, and rural domestic water uses are projected to increase to 60,000, 24,000, and 15,000 acre feet respectively by year 2001 (Underwood McLellan 1978c, p.12, 16). These projections are based on forecasts of population and industrial growth, and are subject to change in growth trends or changes in consumption affected by conservation programs, metering, or pricing arrangements.

The Environment Council feels that the consumption of water by municipal, industrial, and rural users will continue to be a small portion of the total water withdrawals in the basin and that adequate water is available to meet these needs. Even in the summer of 1977, when flows at Lethbridge dropped to 188 cfs, flows were adequate to meet the water supply requirements of Lethbridge, although it was physically difficult for the pump station to operate.

Municipal and domestic use should continue to have priority over other uses. However, in times of water shortages, these needs should not continue to be filled without restraint, but should be reduced as much as possible to accommodate other users. Several briefs (13, 16, 94) commented upon the lack of a water conservation or rationing program in the City of Lethbridge during the low flow periods of 1977. Such should not be the case. The Environment Council believes that the communities of the basin should be models of good water stewardship. Water conservation is a normal, prudent practice in water deficient areas.

4.3.3 Instream Flows

Present

Table 4 shows the current minimum flow criteria at locations in the Oldman River Basin. These are the minimum instream flows which are practical to maintain with the present water storage capacity and at the level of irrigation development which must be supplied. However, flows substantially less than these values have occurred. The present minimum flow criteria do not place a major emphasis on fish habitat or recreation uses.

Table 4

Minimum Streamflow Criteria[1]
Oldman River System

Location	Present Minimum Flow cfs	Near Future Minimum Flow cfs	Far Future Minimum Flow cfs
Oldman River at Lethbridge	Varies to as low as 200 134 - 31/8/36[2] 92 - 23/11/77[3]	360	360
St. Mary River below St. Mary Reservoir	30 0 - 25/7/36 and twice since[2]	30	97
Belly River below Belly River Diversion	30 6 - 5/11/60[2]	30	33
Waterton River below Waterton Reservoir	30 1.4 - 19/3/65[2]	30	80

1. Modified from Management Committee report, Table 16, p. 63.

2. Underwood McLellan (1978c)

3. Environment Canada (1978)

Footnote: These are minimum flow criteria, hence, flows should not fall below these levels and will usually exceed these minima.

Future

In developing its strategy for water management with the Oldman River Basin, the Management Committee recommended the increases in streamflow minima shown in Table 4 to meet minimum requirements for fish habitat in the far future; 10 per cent of the mean annual flow. Under the conditions of the Water Balance Model, near future and far future water supply alternatives must supply these minima. The Management Committee believed that minimum instream flow criteria should not be set higher than 360 cfs at Lethbridge in an attempt to satisfy the streamflow requirements specified for "good" fish habitat, canoeing, or dilution of phosphorous, in view of higher priority needs. The Department of Recreation, Parks and Wildlife, however, stated that 10 per cent of the mean annual streamflow represented an absolute minimum and that, until further studies have been completed, planning should be based on maintaining "good" flows (20 per cent of mean annual flow during October to March and 40 per cent of mean annual flow during April to September).

Eight briefs (2, 6, 11, 13, 88, 128, 177, 179) received during the Hearings made comments related to the minimum streamflow targets recommended by the Management Committee. Concern was expressed in five briefs, that the target minimum flows were either too low (briefs 6, 11) or lacked any guarantee that flows would not be reduced further if irrigation required additional water (briefs 6, 88, 128, 179). These latter briefs requested that the basic instream flows be given a higher priority than irrigation needs or established as "minimum" flows rather than targets. Examples were cited to illustrate the lack of guarantee for instream flows: the excessive withdrawals from the Bow River in 1977, and the almost total diversion of water from the Oldman River to the LNID in the summer of 1977.

The City of Lethbridge (brief 13) desired assured minimum flows of approximately 360 cfs for the benefits provided to their water supply system. Medicine Hat (brief 177) feared that a controlled minimum flow might create problems due to algae growth, unless spring flooding occurred to scour the river. One brief (2) stated that the Management Committee's target minimum flows were adequate for fisheries since the fish resources appear to have survived lower flows during August 1977.

The Environment Council responded to the comments raised and concerns expressed, by meeting with the Department of Recreation, Parks and Wildlife and Alberta Environment and by reviewing streamflows projected by the Water Balance Model. The staff of the Department of Recreation, Parks and Wildlife (Fish and Wildlife Division) reiterated their concerns, that if the 10 per cent targeted flow became the normal operating streamflow, the Oldman River could suffer a reduction in fish populations as a result of the combined impact of low flows and high summer water temperatures.

Alberta Environment stated that such concerns were unfounded and streamflows would greatly exceed 360 cfs at Lethbridge most of the time. Average monthly minimum flows projected by the Water Balance Model always exceed 360 cfs at Lethbridge and substantially exceed this minimum most of the time. In the near future, the supply schemes would allow a greater spring diversion to increased offstream storage in the LNID and, hence, less water would be diverted and greater flows could be maintained in the Oldman River during the summer. The model suggests that, in the far future, water released from an onstream reservoir on the Oldman River could be pumped into the St. Mary Project below Chin Coulee Reservoir to supply the irrigation districts. This pumping would permit greater releases from the Waterton and St. Mary Dams (totalling 210 cfs) without decreasing the irrigated acreage in the St. Mary Project. These increased flows combined with the releases from the reservoir on the Oldman River would provide flows capable of meeting the 360 cfs flow criteria for Lethbridge.

It should be noted that within the Water Balance Model flows were balanced on a monthly basis and that only an average monthly flow of 360 cfs is guaranteed.

The Environment Council recommends that the minimum streamflow criteria of 360 cfs at Lethbridge be accepted and, if at all possible, be ensured as an instantaneous minimum. The water supply facilities which the Environment Council recommends (see Sections 7 and 8) will ensure continuous flows on the Oldman River exceeding 360 cfs at Lethbridge. This is possible because sufficient water can be diverted from the Oldman River during high flow periods and stored in offstream storage facilities to supply all irrigation demands north of the river for the low flow period. Diversion from the Oldman River can, therefore, be halted if instream flows threaten to drop below 360 cfs. Indeed, flows could be augmented, if necessary, by releasing up to 200 cfs from Mud Lake into the Oldman River via Willow Creek (see Section 8.4). Releases from the Waterton and St. Mary Dams could also be increased, in emergencies, to ensure the 360 cfs flow at Lethbridge.

The Environment Council recommends that for the Waterton, Belly, and St. Mary Rivers, minimum streamflow criteria of 30 cfs on each calculated on a mean monthly basis should be the objective. The implementation of this recommendation will not result in any improvement over the present flows in these three rivers. The Environment Council does not agree with the Management Committee that such increases are warranted. There seems to be little to justify increased flows on these rivers. The natural environments of the St. Mary, Belly, and Waterton Rivers have already been destroyed by dams and diversions. Fish populations and recreation opportunities have been drastically reduced by years of low summer flows.

The Environment Council is aware that none of the water supply alternatives can guarantee minimum flows 100 per cent of the time. Between November 21 and November 24, 1977, flows measured at Environment Canada's gauging station on the Oldman River near Lethbridge were between 92 and 96 cfs even though no water was being diverted from the Oldman River (Environment Canada 1978). The cause was natural; ice was forming and substantial quantities of water were being converted to ice. The flow increased to 176 cfs on November 26 and to 479 cfs on November 31 after the initial period of rapid ice formation. While it is recognized that such natural events probably cannot be prevented, the Council is satisfied that the water supply alternatives recommended (see Sections 7 and 8) will ensure instantaneous flows of 360 cfs at Lethbridge and 30 cfs in the St. Mary, Waterton, and Belly Rivers under most circumstances and, in particular, throughout the summer months. Maintenance of adequate streamflows is important during the summer, since high water temperature and lowered dissolved oxygen levels when combined with low streamflows may result in substantial fish kills. During colder weather, fish are less active, require less dissolved oxygen and can better tolerate temporary reduction in streamflows.

The Environment Council is satisfied that under the water supply alternative recommended there will be assured flows in the Oldman River at Lethbridge sufficient to meet the city's water supply requirements. Instream flows should increase sufficiently in the spring to provide the scouring action desired by Medicine Hat (brief 177). This scouring is not, however, a solution to the water quality problems at Medicine Hat (see Section 4.4).

Earlier, it was mentioned that the Department of Recreation, Parks and Wildlife had expressed the view that 10 per cent of the mean annual flow was inadequate for fish resources and that higher flows should be targeted until further studies are done. The Environment Council recommends that the Fish and Wildlife Division proceed immediately with the studies that are necessary to determine the seasonal instantaneous flow requirements for fish populations. Upon completion of these studies, flow requirements should become integrated into the operating regimes of the Oldman River Basin and used in preparing alternatives for the broader South Saskatchewan River Basin Planning Study.

4.3.4 Irrigation

Present

In 1977, there were 540,168 acres on the assessment roles of irrigation districts in the Oldman River Basin. These districts diverted 726,100 acre feet of water from the Oldman, Waterton, Belly, and St. Mary Rivers. The assessed acreage and diversions for the five years 1973 to 1977 are presented in Table 5. A very small portion of the water diverted through the irrigation systems is withdrawn for domestic use by communities along the system. Underwood McLellan (1978c, pp. B 23-24) estimated the total domestic withdrawals from all irrigation systems at 3,136 acre feet.

Using irrigation figures based on water licences issued by Alberta Environment, Underwood McLellan (1978c) estimated that authorized annual water use by private irrigation schemes in the study area totalled 82,000 acre feet as of November 1977. These licences include 68,000 acre feet of withdrawals from drainages from the Crowsnest River to the South Saskatchewan River at the border between Alberta and Saskatchewan and 14,000 acre feet of withdrawals in internal drainage basins, such as Etzikom Coulee. Private irrigation is not concentrated in a particular area. Alberta Environment, Water Rights Branch estimated that, on January

Table 5

Water Diversions and Assessed Acreages* for Oldman River Basin Irrigation Districts 1973 - 1977

Irrigation District	1973	1974	1975	1976	1977
Lethbridge Northern					
Assessed Acres	98,206	104,334	108,106	109,629	111,736
Diversion (Acre Feet)	172,000	161,000	106,000	155,000	169,000
Magrath					
Assessed Acres	9,182	9,077	8,871	9,069	9,480
Diversion (Acre Feet)	17,200	9,900	7,700	7,600	14,300
Mountain View, Aetna, Leavitt					
Assessed Acres	11,105	11,218	11,231	11,231	11,231
Diversion (Acre Feet)	25,600	17,200	9,780	13,600	26,700
St. Mary River, Taber, Raymond					
Assessed Acres	297,414	323,081	341,631	353,855	374,104
Diversion (Acre Feet)	475,000	430,000	211,000	465,000	485,000
United					
Assessed Acres	33,353	34,034	33,358	33,358	33,617
Diversion (Acre Feet)	33,600	21,900	14,800	15,000	31,100
TOTAL					
Assessed Acres	449,260	481,744	503,197	517,142	540,168
Diversion (Acre Feet)	723,400	640,000	349,280	656,200	726,100

Based on information from the Irrigation Council and Environment Canada Surface Water Data.

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* Assessed acreages excludes acres under commuted rates (those acres previously under irrigation now taken out of agricultural use).

8, 1979, projects in good standing required 103,859 acre feet of water from the Oldman River Basin.* This figure does not include private irrigation downstream from the Bow-Oldman junction.

Future

For the purposes of testing the water supply alternatives in the Water Balance Model, Underwood McLellan (1978c) suggested water withdrawals by private irrigation would double to 128,000 acre feet by 1985 and triple to 192,000 acre feet by 2005. The report noted that a more realistic estimate was a 40 per cent increase on a base of 68,000 acre feet of withdrawals by 1985 and doubling by 2005. The main factor suggested as affecting expansion of private irrigation systems was the lack of water available during low summer flows and the dependence of development on future water management facilities and policies. It pointed out that potential exists for developments which utilize local spring runoff. Information from Alberta Environment suggests that private irrigation is presently utilizing 103,859 acre feet above the Oldman-Bow junction.

One person (brief 79) with a private irrigation permit expressed concern over the future of onstream irrigation in the face of increasing diversions to irrigation districts. Under the terms of licence, he could be required to cease irrigation in low flow conditions and he had expected this to occur during 1977, but it did not happen. He suggested that existing onstream licences should have priority over new water rights in irrigation districts, rather than have any new irrigation incorporated under the blanket licence of the district.

The Water Balance Model indicates that there is adequate water available in the Oldman River Basin to support approximately 899,000 to 929,000 acres of irrigation at current efficiencies depending upon the water supply alternative selected (Management Committee 1978, p. 28). However, the Management Committee felt 850,000 acres should be considered the ultimate limit. Irrigation water demands were based on existing water diversion data (acre feet per acre) extrapolated for increases in acreage within the constraints of instream flow needs and the failure criteria. Any increase in water delivery to the farm, through improved delivery efficiencies was assumed to be used as additional water applied per acre. In addition, a 15 per cent increase in water use per acre was assumed for acreage in the St. Mary River Irrigation District. The total includes 129,000 acres of private irrigation.

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* This figure is considered to more accurately represent the present situation. Information obtained by Underwood McLellan (1978c) from Alberta Environment covered active licences in the study area up to November 1977.

Improving delivery system efficiency and on-farm use is, in the opinion of the Environment Council, likely to result in lower diversions per irrigated acre. (See Section 6.) Diversion requirements depend on how much the farmer increases his water applications, and this depends on the economic balance between increased water application and improved crop yields. The additional water made available as a result of lower diversions could be used to increase stream base flows, to increase private irrigation, or to increase development in irrigation districts.

As well as the above assumptions, the Management Committee established criteria for water shortages which could be endured without experiencing a serious reduction in crop yield or farm income. The Water Balance Model considered water use requirements to be met if:

1. the frequency of occurrence of a water shortage of greater than 10 per cent of requirements was less than one year in ten;
2. the frequency of occurrence of two consecutive years with water shortages greater than 20 per cent of requirements was less than one year in forty.

As a further guide, the model operated to minimize the occurrence of water shortages of more than 25 per cent in any one year; although the estimates of the acreage that could be irrigated were not constrained by the occasional occurrences of a shortage of this magnitude (Management Committee 1978, p. 21).

The Environment Council feels that the "failure criteria" used are stringent and should not be used as absolute criteria for rejecting marginal schemes. Shortfalls within the model were considered cumulative during the irrigation season resulting in "failure" of suggested supply schemes whether the shortages were 2 per cent a month for 5 months or 10 per cent in 1 month. Shortfall calculations also make no consideration of crop susceptibility. Also, the "failure criteria" do not reflect the increases that are projected to occur between present and the far future in the volume of water delivered per acre. Despite these shortcomings, the concept of "failure criteria" is endorsed as a tool to be used by irrigation districts for planning the allocation of a scarce resource. It can no longer be assumed that all water desired will be made available every year.

4.3.5 Private Irrigation

Information from Alberta Environment, Water Rights Branch shows that up to January 8, 1979, there were 279 licences and 192 interim licences for private irrigation in the Oldman River system to the confluence of the Oldman and the Bow Rivers. This amounts to a total allocation of 103,859 acre feet or about 69,000 acres based upon a licensed entitlement of 1.5 acre feet/acre irrigated. The volume of water used and the number of acres irrigated is not known because of monitoring difficulties. Many licensees have made substantial capital investments in irrigation equipment and land preparation. It is important that they do not suffer water shortages beyond the failure criteria applied to other irrigation farmers.

When water can be withdrawn from stream flows that are maintained for other reasons, such as protection of fisheries, the onstream sprinkler irrigator uses water very efficiently because delivery losses are almost non-existent. On the other hand, the maintenance of stream flows solely to provide for private irrigation is a very inefficient use of water.

The above information from the Water Rights Branch suggests that if all private irrigators are using their allotment of water the practical limit of private irrigation may have been reached. Any increase may result in unacceptable water shortages either to the private irrigators or to the proposed incremental acres recommended for the districts. Consequently, the Environment Council recommends that no further licences be granted to private irrigators until Alberta Environment, or Alberta Agriculture, or both, determines the amount of water now being used and is satisfied that there is sufficient water to supply new private irrigators. If, after this review, adequate water is found to be available, the Environment Council recommends that priority be given to applications from east of the confluence of the Little Bow and Oldman Rivers. This is consistent with the overall plan to use available water where the highest economic returns can be expected.

The Council notes that the procedures used to process new applications provide mechanisms for complete scrutiny of the application by all departments of government that would have an interest and by individual citizens who may be affected. While this procedure is time consuming for all concerned, the Council agrees that these procedures are necessary for good water management. Unfortunately, the monitoring of what actually happens after the licence is granted may be inadequate. While the difficulties are substantial and the Council has no specific plans to suggest, it recommends Alberta Environment and Alberta Agriculture review the administrative procedures with the objectives of providing practical methods of monitoring water uses and of putting into effect mechanisms that would enable them to ration users in an equitable manner should low flow periods make this necessary.

The Council reiterates that private irrigators should be protected from unacceptable shortages. It is realized that there may be more water available than has been estimated. If additional information becomes available and practical administrative machinery allows for careful management it may be possible to accommodate additional users, especially in years when stream flows are high.

In the view of the Council, even if water is available, demand is likely to lessen primarily because of constantly increasing energy costs. These costs are dependent on the head and the distance water has to be pumped. It is assumed that the most attractive parcels, those with low heads and short pumping distances, have likely been developed and that future projects, squeezed between unfavourable sites and advancing energy costs, will be more expensive. Under these circumstances private, onstream, irrigation projects should be treated as a residual, without special and increased water allocations, and assigned whatever water is available after other irrigation users, that have more stable input cost prospects, are satisfied.

4.4 WATER QUALITY

For the most part, natural water quality in the Oldman River Basin is relatively good. Although there are natural conditions such as saline lakes and saline groundwater, Albertans have not yet polluted their water to the extent common in most affluent societies, and can correct existing problems and prevent future problems without tremendous costs or disruption.

There are at present several different approaches to determining the nature and extent of water quality problems in the Oldman River Basin. Water quality objectives have been set by the Prairie Provinces Water Board (PPWB) (Table 6) and its Committee on Water Quality is currently reviewing those objectives. The PPWB has a set of water quality parameters (Table 7). Alberta Environment has set Alberta Surface Water Standards—essentially adopted from PPWB objectives—and grants effluent licences which regulate releases of pollutants to natural bodies of water and has "guidelines" for industrial effluents going into municipal treatment systems (Table 8). However, for some needs the quality determined by the objectives, standards, and licences may be inadequate. Research must continue to determine the extent to which water quality objectives and standards will provide the protection required, especially since natural water qualities vary throughout the province. The terms of licences to dispose of effluents are often expressed in units of waste released per unit of production or with respect to the concentration of the waste. Again, there may be no relationship to the requirements to provide the necessary water quality protection. Finally, there are the perceptions of the public about the quality of the water in natural bodies which may influence standards and their enforcement.

Difficulties have developed in reaching agreement on the nature and extent of water pollution problems because of

a. the use of different measurements for specific pollutants (pounds or tons per year, ppm or mg/l, different chemical entities such as phosphorous as P or PO_4),
b. differences in the standards/objectives,
c. differences in the sampling and measurement techniques, the chemical analyses used, and use of different statistical analyses of results.

It is also important to identify sources of pollutants as to whether they are point sources (released at identifiable and likely controllable points) or non-point sources (diffuse and not likely controllable). A point source for one pollutant may become the cause of a non-point source for another. This is the case when release of phosphates from a sewage outlet (point source, controllable) is a fertilizer which stimulates the growth of algae in the river which then becomes a non-point source of BOD (biochemical oxygen demand) pollution problems when it dies and starts to decay (non-point source, not controllable).

The natural water quality in the Oldman River system changes as the rivers pass from the mountains, through the foothills and out through the plains. Phase I and Phase II Studies on Water Quality indicate that above Lethbridge water qualities are generally good, although they do suggest that the Crowsnest River below Coleman periodically has

Table 6

Prairie Provinces Water Board Objectives for Regularly Monitored Surface Water Quality Parameters

Water Quality Parameter	Maximum or Minimum Value
Coliform Bacteria (Total)	1000* or 5000**/100 ml max.
Faecal Coliform Bacteria	200* or 1000**/100 ml max.
Dissolved Oxygen	5.0 mg/l min.
Suspended Solids	10 mg/l over natural background level
pH Value	6.5 min., 8.5 max., 0.5 units from natural background level
Temperature	3° C over natural background level
Turbidity	25 Jackson units over natural background level
Odour	8 Units
Surfactants (MBAS)	0.5 mg/l max.
Phenolics	0.005 mg/l max.
Fluoride	1.5 mg/l max.
Iron	0.3 mg/l max.
Manganese	0.05 mg/l max.
Nitrogen (Total)	0.5 mg/l max.
Phosphorus (Total as PO_4)	0.15 mg/l max. 0.05 mg/l as P
Sodium (per cent of cations)	30 min., 75 max.
Zinc	0.05 mg/l max.
Cadmium	0.01 mg/l max.
Chromium	0.05 mg/l max.
Lead	0.05 mg/l max.
Mercury	0.0001 mg/l max.
Silver	0.05 mg/l max.
Copper	0.02 mg/l max.

* Geometric mean of not less than 5 samples per month in waters to be used for direct contact recreation or vegetable crop irrigation.

** At least 90 per cent of samples in a month in waters to be withdrawn for treatment and distribution as a potable supply or used for outdoor recreation other than direct contact.

Source: Alberta Environment, Pollution Control Division

Table 7

Water Quality Parameters

* Aldrin
Alkalinity, phenol.
Alkalinity, total
Aluminum, extract.
N-Alkanes
Aromatic Hydrocarbons
* Arsenic, diss.
Barban
* Barium, extract. (Q)
BHC - (alpha)
* Boron, diss. (Q)
* Cadmium, extract. (Q)
Calcium, diss.
Carbon, total, inorganic
Carbon, total, organic
Chloride, diss.
Chlorophyll A
* Chromium, extract. (Q)
Coliforms, fecal
Coliforms, total
* Color, apparent
* Copper, extract. (Q)
* Cyanide, total
* P, P-DDT
* P, P-DDD
* P, P-DDE
* Dieldrin
Endosulfan-alpha
Endosulfan-beta
* Endrin (Q)
* Fluoride, diss.
Hardness, total, $CaCO_3$
* Heptachlor
* Heptachlor, epoxide
* Iron, extract.
* Lead, extract. (Q)
Gamma-BHC
Magnesium, diss.
* Manganese, extract.
* MBAS Surfactants
MCPA
* Mercury, extract.
P, P-methoxychlor (Q)
NTA
Nitrogen, TKN
Nitrogen, diss., NO_3+NO_2
* Nitrogen, total
* Odour, TON
* Oil and Grease
* Oxygen, demand, BOD
* Oxygen, diss., DO
PCB, Arochlor 1248
PCB, Arochlor 1254
PCB, Arochlor 1260
* pH.
* Phenolics
* Phosphorus, total
Potassium, diss.
* Radioactivity Gross Beta
* Radium 226
* Residue, nonfilterable
Residue, fixed, nonfilterable
* Selenium, diss. (Q)
Silica, reactive
* Silver, extract. (Q)
* Sodium, diss.
Specific Conductance
* Strontium
Sulphate, diss.
* Temperature
Tordon, (Picloram) (Q)
* Turbidity
Trifluralin
Vanadium, extract.
* Zinc, extract. (Q)
2, 4-D
2, 4-DB
2, 4-DP
2, 4, 5-T

(Q) - quarterly sampling
* Objectives exist

Source: Prairie Provinces Water Board Water Quality Branch, Environment Canada.

Table 8

Limits on Wastewater to be Discharged to Municipal Systems

The following limits are intended to be a guideline for small to medium-sized municipalities. They indicate what a municipality may be able to safely accept into their treatment plant. If a municipality believes that they can absorb a stronger waste because of the size and capacity of their system then they are free to do so, however, in the end, they must be able to meet Provincial final effluent requirements.

General goals for a waste water discharge to a sewerage system are that the wastewater must be essentially free of:

1. Material which is floatable;
2. Solids that will settle out and deter the flow in pipe;
3. Toxic substances;
4. Excessive discoloration which is undesirable and unaesthetic; and
5. Noxious odours.

A more detailed description of limits follows.

Basic Limits for Industrial Effluents Discharging to Municipal Sewers

A. Prohibited Materials

No person shall release, discharge, suffer or allow the following sewage or waste to enter into the sewerage system:

1. Any flammable or explosive materials;
2. A solvent or petroleum derivative including but not limited to gasoline, benzine, naptha, or fuel oil;
3. Water containing wastes from oil or petroleum;
4. Any chlorinated hydrocarbons;
5. Carbon bisulphide, hydrogen sulphide, ammonia, trichlorolethylene, sulphur dioxide, or formaldehyde;
6. Any pesticides or herbicides;
7. Any corrosive, noxious or malodorous material or substance which, either by itself or by reaction with other wastes is capable of:
    a) causing damage to the sewerage system, or
    b) creating a public nuisance or hazard, or
    c) preventing any person entering the sewers for purposes of maintenance or repair;
8. Waste which, either by itself or upon the reaction with other material becomes highly colored;
9. Sewage have a pH rating less than 6.0 or greater than 9.0;
10. Any waste animal parts or remains from meat processing or rendering or hide processing operations;
11. Any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, tar, plastic or wood;
12. Sewage containing a radioactive substance;
13. Sewage having a temperature in excess of 65.5^0 C;
14. Grit removed from commercial or industrial premises including but not limited to grit removed from car washing establishments, automobile garages and restaurant sumps or from interceptors;
15. Any corrosive or toxic sewage or other wastes which could adversely affect the sewerage system;
16. Sewage which will create tastes or odors in drinking water supplies making such waters unpalatable after conventional water purification treatment.

(Table 8 cont.)

B. Limitation on Wastewater Characteristics

	Maximum Limits mg/l	Maximum Canadian Drinking Water Standards 1968 mg/l
Arsenic	0.1	0.05
Cadmium	0.2	0.01
Chromium	0.5	0.05
Copper	1.0	1.0
Cyanide	1.0	0.2
Lead	1.0	0.05
Mercury	0.01	-
Nickel	0.5	-
Phenolic Compounds	0.1	0.002
Silver	0.2	0.05
Sulphides	3.0	0.3
Zinc	2.0	5.0
Chlorinated Hydrocarbons	0.02	-
BOD	1000**	-
SS	1200***	-
O & G (Animal or Vegetable Origin)	300	-
O & G (Mineral or Petroleum Origin)	100	-

* The suggested limits are for an individual industrial discharge, and not the total municipal discharge.

** Wastes in excess of 300 mg/l should be subject to a surcharge fee.

*** Wastes in excess of 350 mg/l should be subject to a surcharge fee.

Source: Alberta Environment 1978b.

water quality problems. This has been confirmed by cases of sickness and tests which showed *E. coli, Shigella, Salmonella,* and *Proteus* from that river in the summer of 1977. One brief (151) stated that occasionally the water supply for the Town of Cowley does not meet health standards. Another brief (221) included information on coliform and fecal coliform tests on Crowsnest River water during 1977. The problem here is design of sewage treatment facilities with adequate capacity so that untreated sewage does not have to be bypassed, and proper operation of all facilities, so that complete disinfection is achieved.

According to background studies, a satisfactory water quality is maintained at Lethbridge likely because Crowsnest River water becomes diluted as it progresses downstream. Below Lethbridge there are periods when BOD (biochemical oxygen demand), and phosphate (or phosphorous, P) concentrations are too high and dissolved oxygen levels are too low (Envirocon n.d., p. 24). Willow Creek and the St. Mary River below the dam show occasional high phosphate levels.

The Bow River causes serious problems in the South Saskatchewan River below the confluence of the Bow and Oldman Rivers because of the very heavy phosphate loadings. "Summer phosphorous concentrations in the Bow River are such that ASW [Alberta Surface Water] standards are exceeded approximately 70 per cent of the time" (Envirocon n.d., p. 24). Although there are identifiable sources of problems on the Oldman River which should receive treatment, without adequate treatment of sewage from the City of Calgary, the water quality problems of the South Saskatchewan River in Alberta will never be solved.

Alberta Photographic Services

Flood irrigation using an open ditch for water delivery.

Because Alberta receives water from the U.S.A. and Alberta water flows to Saskatchewan, there is a federal government interest in water quality in the province. At present, there seems to be no problem with water flowing into Canada from the U.S.A. However, the Master Agreement on Apportionment involves the federal government (and the governments of Saskatchewan and Manitoba) in water quality issues in the Oldman River Basin. The federal government's Canada Water Act, Pest Control Products Act, Environmental Contaminants Act, Fisheries Act, Criminal Code, and Canada Animal Waste Management Guide, are instruments which might be used to control water quality problems in Alberta.

The main pieces of legislation in Alberta which could be involved in the control of water quality are the Clean Water Act, the Public Health Act, the Agricultural Chemicals Act, and the Irrigation Act. (The Irrigation Council also has very strong powers under the Irrigation Act for the control of water quality in the irrigation systems.) The Confinement Livestock Facilities Waste Management: Code of Practice should be important, but is extremely weak. The Clean Air Act, the Soil Conservation Act, the Land Surface Conservation and Reclamation Act, the Department of Environment Act, the Public Lands Act, the Water Resources Act, the Forest and Prairie Protection Act, and the Forests Act contain provisions pertinent to maintenance of water quality.

Of course, the protection afforded by legislation is only as strong as the will and the ability of the Ministers and their officials to enforce the legislation. As indicated above, there is a broad range of federal and provincial legislation which includes powers to pass regulations to control water quality. Certainly, public willingness to comply is the easiest and cheapest approach.

4.4.1 Municipal/Industrial

4.4.1.1 Treatment Facilities (Effluents)

In addressing the issues of water quality, different water quality problems must be identified and the appropriate corrective measure applied. The Prairie Provinces Water Board water quality objectives are shown in Table 6. Those water quality parameters of concern to the PPWB, and therefore of concern to Alberta with respect to the Apportionment Agreement, are listed in Table 7. The objectives have generally been adjusted to ensure that all aspects of water quality are maintained at a satisfactory level. Such objectives must be reviewed and adjusted periodically to accommodate increases in amounts of pollutants released or newly identified problems. Population increases, more intensive agriculture and industrialization are the major influences.

Sewage borne diseases are generally not tested for directly. Their presence is indicated by tests for coliform and fecal coliform which show the water is contaminated by inadequately disinfected sewage or animal wastes.

The oxygen content of water (dissolved oxygen, DO) is an important parameter. Biochemical oxygen demand (BOD), organic material that consumes/demands oxygen as it decays in water, is another measurement done on water or effluents entering water to determine the level of pollution. BOD in sewage or industrial effluents is treated through secondary treatment. In the Oldman River Basin, the nutrient-stimulated growth of algae can cause problems directly by plugging water pump intakes, increasing water treatment costs, and indirectly by creating BOD when they die and decay. Nutrients are removed from effluents by tertiary treatment, or by land disposal (utilization) of secondary effluents through irrigation where the nutrients are useful rather than a source of problems.

The Phase II study states "There are only five areas in the river where oxygen regimes may become critical" (Envirocon n.d., p. 24). This implies that southern Alberta is well on the way to solving this pollution problem, which is not completely true. Five areas with oxygen problems are five too many. The objective should be to ensure that all stretches of the South Saskatchewan-Oldman Rivers have adequate oxygen levels. To achieve this objective, it is essential that the systems are operated properly and that they are enlarged and upgraded as pollution loads increase. It will be necessary to monitor water quality to see that the current conditions of effluent licences (eventually 25 ppm for BOD and SS) for the treatment plants in Calgary and Lethbridge are stringent enough to maintain water quality at an acceptable level whether or not that level is within the current Alberta Surface Water Standards and Prairie Provinces Water Board Objectives.

Alberta Environment has developed a set of guidelines for industrial effluents dumped into municipal treatment systems (Table 8). Industrial effluents disposed of by dumping into natural waterways must be licensed by Alberta Environment. If the guidelines and licences are set to provide adequate protection, are managed properly, enforced strictly, and adjusted for growth, no new problems should develop and existing problems should be cleared up.

The sugar plants at Taber and Picture Butte were identified by the Management Committee as major sources of BOD problems. The plant at Picture Butte has been shut down and so is no longer of concern. The plant at Taber does not yet comply completely with the levels of BOD set by the licence with Alberta Environment. However, they have established a water recycling system for the plant which has eliminated the largest part of the BOD problem. Further work on smaller sources in the plant during the spring and summer of 1979 should bring it within the guidelines. The plant will continue to dispose of clean "condensate" water to the river.

The background reports seem to conflict on whether or not the gas plants in the western part of the basin cause any nutrient problems. Although Envirocon (n.d.) suggests there is no problem, the Alberta Environment (1978a) wastewater utilization study (1978a) indicates that serious attention should be given to the need for treating gas plant effluents. Most other industrial effluents are now apparently adequately treated or are dumped into municipal systems.

The briefs which addressed the issue for the Environment Council were unanimous in their calls for improved water quality. However, some, such as the

City of Lethbridge (brief 13), were reluctant to do anything to help improve water quality for those downstream unless required by government to do so. The City of Medicine Hat (brief 177) suggested that the installation of tertiary treatment systems could be delayed, but that they would not ask anything of those upstream that they were not prepared to do themselves.

A large number of briefs endorsed onstream storage and the flow regulation it could provide because it was suggested that flow regulation could be used to improve water quality and avoid the need to install tertiary treatment systems (13, 46, 48, 50, 72, 90, 177, 180, 199, 220). The background studies do not support the suggestion that flow regulation could be effective in improving water quality, especially in the lower reaches of the river. It is true that in 1971, as an interim measure, releases from the St. Mary Reservoir were started in an effort to maintain water quality. However, these releases compromise the other uses of the reservoir and do not adequately handle the water quality problem. Under 1975 conditions, seasonal minimum flows required to meet water quality standards at Lethbridge would be: spring—9,673 cfs; summer—12,407 cfs; fall—7,020 cfs; winter—5,969 cfs (Envirocon n.d., p. 39). The minimum flows given in the Management Committee report (p.15) are, therefore, not adequate to meet all water quality criteria. Such minimum flows are far above the 360 cfs used as a minimum flow criteria in this report.

Other factors suggest that flow augmentation is an ineffectual way of trying to avoid installing necessary tertiary treatment systems. Alberta Environment (1976, v. V), notes that increased releases of water to augment low winter flows are often ineffectual because they are consumed by ice formation. During very cold periods, heavy ice formation exacerbates water quality problems by preventing aeration (reoxygenation) of the water, by reducing flows by holding the water as ice and constricting flows from groundwater, and by concentrating pollutants through the formation of ice as pure water, leaving the pollutants in the flowing water. Another reason why flow augmentation would not be an adequate solution to water quality problems, even if adequate minimum flows could be maintained, is the fact that while problems do occur at low flows, there is not a good correlation between water quality problems and flows. This is not unexpected because the heavy contributions to pollution from feedlots and the dumping of sewage lagoons periodically adds heavier loads during higher flow periods.

The water quality problems of specific communities were identified during the Hearings. The wastewater treatment systems in the Crowsnest Pass should be upgraded with the assistance of the Alberta Environment Municipal Sewage Treatment Assistance Program and supplementary CMHC programs. This would be in line with comments received by the Environment Council from people from the Pass (Discussion at Cowley: Wallace) and would reduce or eliminate water quality problems downstream (briefs 109, 151, 221). It is likely that the nutrients provided to the river system by the sewage outfalls have improved fishing in the river without causing other noticeable problems to date. Further, land disposal of sewage effluent, which is probably one of the easiest and potentially most profitable disposal/utilization methods, is not possible in the Pass (Alberta Environment 1978a). At present, the major problems appear to be associated with ensuring adequate secondary treatment and disinfection. Given the relatively small flows of the Crowsnest River, however, as the populations in the Pass increase (including tourist populations), some form of tertiary treatment will become necessary. It is hoped that a monitoring program and forethought will ensure that necessary action will take place before serious problems develop due to nutrient loading. The Crowsnest Pass hopes to benefit economically from the excellent fishing in the area so a careful balance must be maintained between nutrient levels which enhance fishing and those which would cause pollution problems which would detract from the tourist industry, or cause other problems.

Although comments were received about the problems of disposal of sewage from the sewage lagoon at the Town of Cowley, with recent enlargement of that lagoon and arrangements with a local farmer to irrigate from it, those problems should be reduced or eliminated. Of course, any irrigation should be done with careful consideration of those down wind.

There do not seem to be problems associated with sewage disposal from Pincher Creek and Fort Macleod where there is a commendable awareness and willingness to see that relatively new facilities are operated as effectively as possible. The issue of sewage treatment for Claresholm has been resolved by use of a lagoon and spray irrigation. Lethbridge creates major water quality problems with both BOD and nutrients (with the resulting algae growth). The Council was urged to see that improved quality of water supply was available to Lethbridge (brief 13).

The "unidentified" source of pollution near the City of Lethbridge which came to light in the Envirocon study (n.d.) should be identified by Alberta Environment quickly. However, regardless of whether or not the "unidentified" source is discovered and treated, the city itself is a significant source of pollution. The current updating of the secondary sewage treatment system and the installation of industrial pretreatment for those industries releasing effluents to the city's system should reduce considerably the direct BOD load on the river. At present, the licence with Alberta Environment permits releases of 35 ppm (mg/l) of BOD and 35 ppm (mg/l) SS (suspended solids) in Lethbridge's effluent. These levels will be reduced to 25 ppm for both BOD and SS when the new systems are in place and operating effectively. The licence does not deal with the issue of nutrient releases and, therefore, the point source of nutrients has become a non-point source of algae and BOD problems. With financial assistance (Alberta Municipal Sewage Treatment Assistance Program) and technical assistance from Alberta Environment, however, Lethbridge should be able to install adequate tertiary treatment or wastewater utilization systems or both.

Flow augmentation from an onstream reservoir has frequently been proposed as the solution, or at least part of the solution, to the low flow water quality problems at Lethbridge. Alberta Environment (1976, v. V), in a crude benefit/cost analysis, suggested that the City of Lethbridge could save more than $200,000 per year with an upstream reservoir.

This ignores the fact that flow augmentation cannot solve the problems completely, and other costs and benefits from alternatives were not calculated. For example, Alberta Environment (1978a) calculated the value of nutrients applied to land with a spray irrigation scheme for wastewater. If the value of the water as irrigation water is added, a rough estimate of the benefits from wastewater utilization would equal the "benefits" so-called of not installing adequate sewage treatment facilities. Further, there was no effort made to estimate the additional costs to water users downstream due to the excessive nutrients (and resultant algae and BOD problems). Although detailed calculations would be difficult, considering all irrigation and domestic water users on the Oldman and South Saskatchewan Rivers, and the city's contribution to their problems, the savings could be considerable. The indirect savings and benefits from improved fishing, recreation, and aesthetics would also be worthwhile. It should be noted that the recreational value of the Oldman River to people in communities east of Lethbridge (such as Vauxhall) have declined as the city's contributions to the pollution of the river have increased.

As documented by Exner (1977), water users on the South Saskatchewan River estimated in 1976 that excessive algae growth caused an estimated $1 million in direct costs. The costs to Medicine Hat were about $500,000. A significant source of biologically available phosphorous in the basin is sanitary sewage from the City of Calgary (Exner, personal communication). The phosphorous problems on the South Saskatchewan/Oldman River system cannot be resolved in isolation. Hence, although Calgary operates within the terms of the licence issued by Alberta Environment, and even utilizes some of its wastewater (Alberta Environment 1978a), the volume of the waste is so large that total utilization appears impossible. Alternative tertiary treatment methods have been studied in some detail (Johnson 1977). The Alberta Municipal Sewage Treatment Program should be used to assist Calgary in resolving the phosphorous loading problem. The nutrient load from the City of Calgary must be reduced if even minimal standards are to be achieved in both the Bow and the South Saskatchewan Rivers.

A representative of the City of Medicine Hat (brief 177), while suggesting that installation of tertiary treatment at Medicine Hat could be delayed, agreed that Medicine Hat would not be prepared to insist that anyone upstream do anything Medicine Hat was not prepared to do. It is reasonable that Medicine Hat not be required to install tertiary treatment systems or start disposal by irrigation until those upstream have done so and operate at a level which reduces the tremendous cost now being borne by Medicine Hat and other downstream users.

The Environment Council recommends that the Departments of Environment and Health investigate the suitability of ozone as a disinfectant for water supplies and wastewater. Ozone does not have the ability to meet the "chlorine residual" guidelines for domestic water supplies. However, that guideline should be seriously questioned because it is not clear that there are benefits from chlorine residuals (unless water supplies are contaminated between the course of treatment and the point of consumption), and there are health reasons to question the intake of chlorinated compounds by humans. Some chemicals produced by chlorination may cause cancer (Muller 1978, Deinzer 1978, Glatz 1978, Loper 1978). If used properly, ozone is a more effective disinfectant than chlorine and can treat some viruses, which chlorine cannot. Ozone assists in the decomposition of toxic organic chemicals, whereas chlorine contributes to the formation of more persistent organic compounds by creating more chlorinated organics. The decomposition of ozone in the disinfection process, or through natural decomposition, produces oxygen which enhances water quality by increasing the level of dissolved oxygen (DO). With a half life of about 20 minutes, ozone does not last long in water at normal temperatures. Finally, the use of ozone reduces problems of odour and colour encountered when chlorine is used as a disinfectant with water containing organic compounds (Evans 1972, Yocum 1978, Prengle 1978).

4.4.1.2 Wastewater Irrigation

The Environment Council agrees with the conclusions of the background study on *Wastewater Utilization in the Oldman River Basin* (Alberta Environment 1978a), and those of the Management Committee based upon that report. The concept of utilizing resources rather than disposing of wastes should be encouraged. The criteria for determining the suitability for wastewater utilization should be applied carefully, and particular attention paid to water demands in wet years and ways of dealing with disposal/utilization during those years when irrigation is undesirable or impossible.

One problem identified in the establishment of wastewater utilization systems was the availability of land for spray irrigation. There are two problems: in some areas, no suitable land is available while in other areas, where there is suitable land, the land is not easily available. If it is reasonable to contemplate expropriation of land for water storage systems, it seems reasonable to consider expropriation of land for wastewater utilization. Of course, this should only be used as a last resort. It must be pointed out, however, that there is some flexibility determining where pipelines should carry the effluent for utilization. The systems can produce revenue which could be used to offset additional costs for capital and operations of systems somewhat farther away than might be ideal.

The experience to date of operation of wastewater utilization systems is considerable. In many societies, the fertilizer value of human wastes is essential for agricultural production. In more affluent/effluent societies, the dumping of wastes into water bodies was stopped because the resulting pollution could not be tolerated. With due consideration for problems with soils, heavy metal contaminations, and the possibility of health problems, the systems operate very effectively. Several southern Alberta communities operate spray irrigation systems to their advantage. Studies at Granum over seven years show that irrigation from the sewage lagoon has not markedly affected soil chemistry (Alberta Environment 1978a). There has been no identifiable trend as far as an impact on groundwater is concerned. Other municipal and industrial systems are operating successfully (Alberta Environment 1978a). In some cases, wastewater utilization is not possible, but land disposal of sludge has been successful rather than disposal into watercourses at high flows or as landfill. In those areas where irrigation is not possible, a high-efficiency system, such as that at Nanton, can produce excellent quality effluent, and the nutrient value of the sludge can be utilized on land (or for land rehabilitation such as with slag heaps or coal dumps in the Pass). The large volume required for winter storage poses problems for spray irrigation of wastewater.

In calculating the desirability of wastewater utilization, efforts should be made to refine the benefit/cost analysis by considering factors such as:

1. the value of the nutrients as fertilizer;
2. the value of the water as irrigation, for example, 4,500 acres required at Lethbridge at $6.00 per acre water charges;
3. the benefits derived from non-pollution by reducing costs caused by algae and BOD; and
4. the value of crops produced.

It must also be pointed out emphatically that although there are good reasons to be concerned about the pollution problems associated with wastewater utilization, those same problems can occur with water disposal of the effluents and are more difficult to control or correct. For example, if there is concern about health problems from either bacteria or viruses, those problems must be addressed whether land or water is used for disposal/utilization. Whereas the viability of viruses and bacteria in water systems is variable, a few hours of sunshine on a land disposal site generally ensures disinfection. Further, if the problem arises, it would be better to have it confined to a known site than to have the problem moving downstream in an uncontrolled fashion.

Similarly, problems anticipated with heavy metals or toxic organic materials are more easily monitored and controlled on a land disposal/utilization site than they are when the problem is dumped into a body of water.

Water conservation programs and metering/pricing systems to reduce per capita water consumption would also act to the advantage of wastewater utilization systems by cutting down the amount of material to be disposed/utilized and, therefore, reducing the capital and operating costs.

The Environment Council is in complete agreement with the Phase I and Phase II conclusions and the summary of them by the Management Committee.

> The Committee is of the view that as agricultural, industrial and municipal development accelerates and the population increases, steps must be taken to reverse the already critical trend toward water quality deterioration. The Committee is firmly convinced that the recycling of nutrients is preferable to the dissipation in, and ultimate degradation of, a biologically viable river system. The present practice of discharging wastes into watercourses is no longer a satisfactory means of disposal in an area like southern Alberta, where water supply is critical. More environmentally acceptable solutions must be employed (p. 40).

4.4.1.3 Storm Drains

Nowhere in the background documents or in the Hearings is the issue of the impact of water quality from storm sewers (and highways for that matter) considered seriously. Nonetheless, the Environment Council feels that experience in other watersheds dictates that this issue be raised.

Although systems to contain and treat storm runoff are expensive, Alberta Environment should implement monitoring programs to determine the nature and extent of the problem and whether control systems should be installed. Sanitary and storm sewer systems and treatment plants should be designed with due consideration for the fact that eventually, if high water quality standards are to be met, the "first flush" through storm sewer systems may require treatment. This problem has been addressed in other communities in Canada where storm sewer effluent has had significant effects on water quality. A solution seems to be a system of holding tanks which are large enough to catch and hold the "first flush" as it washes the dirt from the urban areas. This heavily contaminated material can then be passed through the municipal treatment plant during low flow periods. It is unrealistic to try to pass all urban runoff through the treatment plants because the very high flows during spring runoff and heavy rainstorms overload any reasonably sized system.

4.4.2 Agricultural Uses

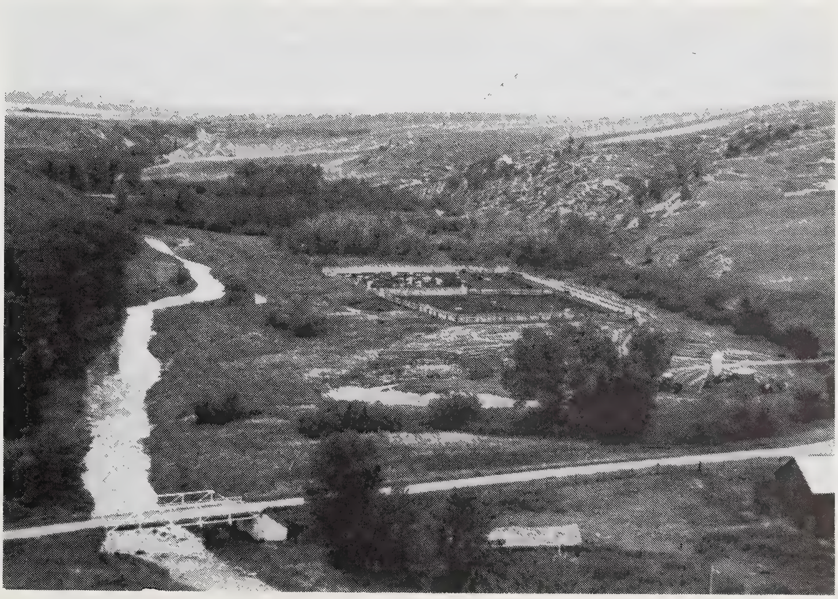
4.4.2.1 Feedlots

There is not sufficient information available to do a detailed analysis of nutrient loadings and other pollution problems from feedlots. However, Envirocon (n.d.) states that "runoff from agricultural land and feedlots is probably the largest single diffuse source of nutrients to the Oldman and South Saskatchewan Rivers" (p. 27). It must be noted that feedlots are considered in that report to be diffuse (non-point) sources because they have not been surveyed, although they could be classed as point sources (and therefore as controllable sources) with more information. A study undertaken by Alberta Environment in 1972 indicates that feedlots have a high potential for creating water quality problems because of the nature of their runoff (Alberta Environment 1972a).

A feedlot is defined by Alberta Environment and Alberta Agriculture (1973) as "any land enclosed by a fence or other means which is used or intended for use for the purpose of feeding or rearing livestock" (p. 4). Later in that report (p. 7), it is suggested that the code's recommendations should only apply where 100 or more head of cattle are kept (or their equivalent in other livestock presumably).

Both the federal and provincial governments have guidelines for feedlot waste management. The federal government's guidelines appeared in 1974 (Agriculture Canada). The guidelines of Alberta Environment and Alberta Agriculture (1973) permit the issuance of a certificate which states that the facility is "considered to be in substantial compliance" (p.24). Although there are statements about the intent of the guidelines to protect the environment, it is clearly stated that "obtaining compliance is intended to give the farmer some degree of protection should there arise a dispute regarding pollution" (p. 2).

When access to surface water was critical for the operation of feedlot facilities, rigid control of the location of those feedlots would have made many operations uneconomical. Now that water can be pumped and controlled relatively easily, the need to have feedlots located on the edges of surface waters has been eliminated. (See Table 9.) Given the increased understanding of the desirability of careful utilization of animal wastes, environmentally sensitive operation of feedlots should not be more difficult or expensive than the earlier mode of operations. Hence, the Environment Council recommends the guidelines of Alberta Agriculture "Confinement Livestock Facility Waste Management: Code of Practice, 1973," be revised to take greater account of the drainage and flood characteristics of individual sites. If there are identifiable cases where water pollution problems cannot otherwise be solved and relocation is the only reasonable alternative, Alberta Environment and Alberta Agriculture should institute a cost-sharing program with farmers for the relocation of feedlot operations. The Council agrees with the recommendations of the Oldman River Planning Commission and the Management Committee that "No new feedlots should be permitted to develop adjacent to watercourses" (p. 63). However, both *adjacent* and *watercourses* should be carefully defined by Alberta Environment and Alberta Agriculture in consultation with the agricultural community.



Dixon Thompson

Many existing feedlots are located close to water courses.

Table 9

Recommended Isolation Distances for Livestock Confinement Systems

Confinement Livestock Facility	Distance to Nearest Edge of Facilities			
	Enclosure, Building, Corrals		Catch Basin, Lagoon	
From	*(1) Required	Recommended	*(1) Required	Recommended
*(2) (1) City	3 miles	5 miles	3 miles	5 miles
*(2) (2) Urban Center (over 500 population)	1 mile	3 miles	1 mile	3 miles
*(2) (3) Urban Center (under 500 population)	1 miles	2 miles	1 mile	2 miles
(4) Public Place	1500 feet	1 mile	1500 feet	1 mile
(5) Country Residence (non-farm)	1500 feet	½ mile	1500 feet	1 mile
(6) Country Residence (farm)	500 feet	½ mile	500 feet	1 mile
(7) Surface Water	50 feet	300 feet	50 feet	100 feet

* (1) Required by Provincial Board of Health Regulations Respecting the Keeping of Livestock and Poultry, Division 23.

* (2) Required only where 100 or more head of cattle are kept.

Source: Alberta Environment and Alberta Agriculture, 1973.

4.4.2.2. Dryland Farming

Dryland farming is the source of water quality problems when poor farming practices cause wind or soil erosion which results in water pollution. The physical transportation of soils into surface waters cause problems with sedimentation, nutrients (both phosphates and nitrogen compounds), and turbidity. In the past, the use of mercurial fungicides has been a source of mercury pollution, but the elimination of these pesticides has prevented further accumulation of mercury in soils and sediments and its transport into water. The adverse impact on water quality from intermittent watercourses may produce problems. For example, an intermittent watercourse covered with natural vegetation is less likely to produce water quality problems during runoff than one which has been cultivated. Similarly, and this would apply to flood plains, the water quality impacts of a natural area would be less than if a feedlot, or other intensive agricultural endeavour, were imposed upon it. Therefore, consideration should be given to effective mechanisms, such as zoning, for protecting intermittent watercourses and flood plains.

4.5 WATERSHED MANAGEMENT

Albertans have long been aware of the relationship between the maintenance of forest cover in the foothills and mountains and the quality and quantity of water in the plains. This critical relationship was acknowledged and confirmed in *A Policy for Resource Management of the Eastern Slopes* (Alberta Energy and Natural Resources 1977, p.4), which states: "The highest priority is placed on watershed management to ensure a reliable supply of clean water for aquatic habitat and downstream users." The Oldman River and its major tributaries all arise in the Green Area. The principal land use in these headwaters is forest cover.

There are three elements or objectives in watershed management: quantity, quality, and timing. Unfortunately, they tend to be contradictory. When one is maximized the other objectives are substantially reduced.

Consider, for example, a virgin forest. Such forests produce the highest quality of water and, because forests are colder and moister than open areas, they tend to delay snow melt. Since an important objective in timing is to delay snow melt as long as possible, this is a desirable feature. Forests, however, consume substantial supplies of water, since they are living plants whose growth depends on evapotranspiration.

An area which has been cleared of forest cover, either by fire or timber harvesting, experiences a substantial increase in water production, on average a 25 per cent increase in clearcuts on the Eastern Slopes (Environment Council 1979). Chinook conditions in the Oldman River Basin may result in lower water yield than experienced further north. Forest openings are hotter and drier and, because of this, the increased volume tends to be available as an increment on peak flows, rather than spread out later into the summer as is the case with a virgin forest. The quality of this increased water also tends to be lower. Since it comes during the peaks, it means that channels are overloaded with resulting excessive cutbanks and silt loading.

If the forest clearing is the result of harvesting, another factor enters. Though serious erosion is extremely rare on recent cutover sites, and can be completely avoided with very simple and inexpensive forestry practices (uniform distribution of slash and debris), the forest access roads are another matter. Here, unless great care, good planning and, frequently, substantial investment is provided, major degradation of water quality can result. Undersized and inappropriate culverts, poorly designed drainage ditches, and insensitive road layout all can contribute very substantial silt loads to streams.

With extreme care, commercial logging could increase water quantity with only a moderate reduction in water quality. It will inevitably provide a deterioration in timing, since most of the extra water will be produced at the time of peak spring flows. Forest hydrologists have been investigating these problems to see if the trade-offs can be reduced. They believe, and the evidence looks promising, that by the use of very small cuts, with openings no greater in radius than the height of surrounding trees, they can increase yields, prolong runoff, and maintain quality. Unfortunately, this approach comes up against another constraint, that of cost. Harvesting these very small cuts with only minimum roading is very expensive, as much as $1,000 per acre with attendant maintenance cutting. Forest hydrologists with the Alberta Forest Service are attempting to establish the types of forest cuts that would still achieve the objectives of water quantity, quality, and timing, while remaining economic for commercial harvest.

One fact that has to be remembered is that time lines in forestry are extremely long, and because the rotation of forestry crops is from 80 to 100 years, if it were decided today that commercial forestry should be directed to maximizing water quantity, it would be about 30 years before the full benefits of that decision would be achieved. Sustained yield forestry implies that only 1 per cent to 1.25 per cent of the total forested area should be harvested in a single year. Since the reduced water demand only lasts for about 30 years before the new growth utilizes as much water as mature trees, the maximum effect would only be obtained after 25 to 30 years of harvesting.

At present, the most important objectives are water quality and timing of runoff. However, the question remains: Will demand for water 25 to 30 years from now be so great that vegetation manipulation should begin now so that water yields are maximized in 2010? The best answer seems to be that by that time, water in the Oldman River Basin will have become a very scarce and precious resource and any increased yields would probably be welcome. However, the costs of establishing and maintaining vegetation cover for maximum water yield is a critical factor; not only the initial and maintenance costs, which are likely to be high and should be carefully investigated, but also the potential costs of lower water quality.

Because of the long time lines, the urgency for a decision soon becomes very real. Alberta Forest Service, Alberta Environment, and Alberta Fish and Wildlife should be set a deadline of 1985 by which time they should decide on the approach to watershed management in the Oldman River Basin. The decision will have no practical effect on the recommendations of the Environment Council for water management in the area. That far into the future, only the most general guidelines are likely to have any validity.

It is clear, however, that water quality will remain a continuing concern. Since road construction is such an important potential contributor to poor water quality, the Environment Council fully endorses the Management Committee recommendation that "Surface disturbing activities such as road construction, pipeline construction and mineral extraction and development must be closely regulated to prevent deterioration of the watershed" (p. 64). Attention is also directed to the recommendations on watershed management contained in *Report on Environmental Effects of Forestry Operations in Alberta* (Environment Council 1979), particularly Recommendations 61 to 64 inclusive.

4.6 GROUNDWATER RESOURCES

The Environment Council agrees with the recommendations of the Management Committee that Alberta Environment should continue to manage, allocate, and license groundwater resources only for rural domestic users, small urban centres, and light industrial users, and that groundwater should not be considered as a source of supply for major irrigation use. Underwood McLellan (1978b) pointed out the inadequacy of groundwater for irrigation in the Oldman River Basin using the example that the total safe yield from all groundwater sources in a 400 square mile area east of Lethbridge would be adequate to supply possibly three square miles of irrigated land, or less than one per cent of the total area. The Environment Council feels that particular uses of groundwater for urban centres and light industrial users, which were identified by Underwood McLellan, should be investigated further. Alberta Environment should determine whether the groundwater sources near Coleman, Bellevue, Hillcrest, and Frank, communities which have water supply problems, can be used, either as a primary or secondary water supply. The cost to develop these supplies appears reasonable. An excellent groundwater supply near Lethbridge may be useful. This area could supply about 1,000 imperial gallons per minute (Nielsen 1971). It is recommended that the city investigate this aquifer as a supply for local industries. The City of Medicine Hat is currently using groundwater for industrial purposes, and Lethbridge may find it beneficial to develop a similar source of supply.

In 1979, the Town of Bow Island experienced considerable problems with water supplies during the very cold winter. The town should investigate the possibilities of using a nearby groundwater source as a primary or secondary source of water.

Three briefs (87, 179, 184) commented on the need for further research concerning the dynamics of groundwater recharge and discharge (87, 184), the use of riparian groundwater supplies (184), and the effect of irrigation on groundwater tables (179).

The Environment Council agrees with the Management Committee that the mapping and evaluation of groundwater capabilities should continue throughout the basin. In addition, the Council recommends that the Alberta Research Council conduct further research on groundwater recharge mechanisms in the foothills and plains. This research would have implications in the artificial recharge of aquifers, use of riparian aquifers, improved utilization of groundwater and surface water resources.

4.7 ENERGY GENERATION

The Environment Council received 11 briefs (13, 41, 74, 87, 90, 138, 181, 183, 189, 200, 203) which commented on the possibilities for energy generation as an integral part of the rehabilitation and development of irrigation systems. The Environment Council supports the recommendation of the Management Committee that feasibility of installing generating capacity at the Raymond Chute and other major drop structures in the irrigation districts should be investigated and generating facilities installed where practical.

Four briefs (41, 181, 183, 200) discussed the use of drop structures within the St. Mary Project for power generation. According to the initial review by the Electric Utility Planning Council (EUPC) (brief 183), electrical generation at the Raymond Chute, which has a drop of 97 feet and a design flow of 3,250 cfs, appears to be economically viable and the EUPC is prepared to undertake detailed studies of the site. The feasibility of electricity generation should also be investigated at other sites including, Chin Coulee Chute, with a drop of 112 feet and a design flow of 1,783 cfs, and the proposed Forty Mile Coulee Chute, which has a drop of between 26 and 76 feet and a design flow of 1,000 cfs. In addition, when the canal between Milk River Ridge Reservoir and Chin Coulee Reservoir is rehabilitated, Alberta Environment, along with the electric utility involved, should study the possibility of combining the six drops in Sections 1, 12, 13, and 24 of Township 6, Range 21, West of the Fourth Meridian. These drop structures, when combined, give a drop of about 150 feet and a capacity of approximately 3,200 cfs. In Section 18, Township 8, Range 18, West of the Fourth Meridian, two drops, which when combined have a drop of 44 feet, could give a capacity of approximately 2,000 cfs, and should also be examined. It is doubtful whether other drop structures between Milk River Ridge Reservoir and Chin Coulee Reservoir could be combined to make a power generation site feasible.

An onstream reservoir could also have potential for hydro-electric generation. The feasibility of developing this potential should be investigated (briefs 13, 41, 74, 90, 181, 183, 203), although it must be recognized that the main functions of the reservoir would be flow regulation and water supply. The potential costs and benefits of electricity generation should be considered auxiliary to the primary functions. The EUPC (brief 183) reviewed the feasibility of power generation at the Brocket and Three River sites. They agreed with the Energy Resources Conservation Board (1978) that both these sites are viable hydro-electric generation sites and would produce power at a lower cost than by fossil fuel generation. The EUPC has stated that through the power utility involved it would be prepared to make the necessary detailed studies along with the required installation at either onstream site. However, they do not feel that the Fort Macleod site is economically viable. From the available information, however, if the Fort Macleod site were increased in both head and capacity as proposed by Klohn Leonoff (1978b) as a possible alternative, this site also might be economically viable.

The EUPC recommends and the Environment Council agrees that the power utility involved should operate any power generation facilities that are constructed and the energy generated should be fed into the Alberta interconnected system since any attempt to operate power generation facilities separate from the Alberta interconnected system would cause a conflict and not make the most efficient use of the facilities. At any pumps that are installed, the district should investigate the value and use of off-peak power or interruptible power in order to obtain the lowest possible rates.

The Environment Council agrees that any hydro-electric power facility on an irrigation system must be designed in a manner that will not compromise the primary purpose of the structure or reservoir whether this function is water supply for irrigation, recreation, or stream flow control. One brief (203) received at the Hearings suggested that there could be conflict between power generation and these other uses and that power could be produced better in other ways.

Three briefs (41, 87, 138) proposed the development of wind and solar power generation. One brief (138) suggested the use of wind and hydro-electric power to pump excess water up into a mountain reservoir for subsequent release into the irrigation system. However, although the Environment Council is not convinced that this would be a viable project, it supports the development of renewable energy sources where possible. The Environment Council recommends that the irrigation districts and Alberta Environment examine the possible use of windmills, or power generation from wind for pumping drainage water into canals or for re-use on farms. Initially, such applications will be for situations in which the volume of water and the pumping head are small, where the rate and timing of pumping are not critical, and likely where power is not readily available.

The EUPC brief also reported that one of its member utilities had examined the feasibility of using Mud Lake as a cooling water source for thermal power generation in southern Alberta. Inasmuch as there are large coal deposits in southern Alberta, the Environment Council recommends that this type of project be examined by the EUPC for future development, with due consideration given to social and environmental impact.

5. MARKETS

5.1 INTRODUCTION

Marketing can be said to be a process of selling available products at a price that on average will yield a profit to the producer. In this section, the assumptions made by Anderson (1978) in regard to markets are discussed; the reaction of people at the Public Hearings is reviewed; and on the basis of material readily available, the prospects for marketing livestock, major crops, and some potential crops are summarized. Finally, the Environment Council concludes that markets will not be a limiting factor in developing the increased irrigation acreage recommended.

5.2 RISKS IN FORECASTING

The success of any business depends on its ability to sell its products at a profit. When contemplating capital expenditures to start or enlarge a business, it is normal to estimate the returns that can reasonably be expected and hence calculate the rate of return on the capital invested. No one can predict future returns with certainty. The degree of confidence that can be obtained varies with the nature of the business.

For example, the cost of constructing a shopping mall and operating expenses can be estimated with considerable accuracy. The time frame involved is relatively short as the building and contents can be written off over a relatively short period of time. The returns are predictable with a fair degree of accuracy. Major tenants agree to long-term leases at given rates. Experience allows one to estimate income from minor tenants. As a result, most shopping centres are successful. Sometimes they are not for reasons that could not be foreseen even by prudent planners.

At the other extreme, a forest industry company may plant trees that will not be marketable for 80 to 100 years. Cost estimates are less reliable because of the long time frame involved. Returns are highly speculative. No one can predict cost of harvesting or market price that far into the future. A potential risk is the possibility that by that time the demand for wood will be low, or that it will have been replaced by other materials. Despite these risks, prudent investors continue to plant trees. If they do not, at some point in time they will go out of business because of lack of raw material. Risk is inherent in any project, yet it is interesting to note that all tree plantings that have reached the harvesting stage have been profitable. Profits would have been greater if plantations had been larger.

The proposals for increasing irrigation fall between these extremes. It seems useful to examine in a general way the degree of risk involved in projecting future profits in this industry.

In his report on the economics of irrigation expansion Anderson (1978) states:

> Our basic analysis essentially assumes that the cropping pattern on irrigated land which prevailed during 1974-76 will continue during the economic life of the project while product prices (in 1977 dollars) will reflect real relative price levels characteristic of the 1967-76 period (p. A-97).

By implication this assumes that products will be sold, and at prices that on average will maintain historical margins of profit. At the Public Hearings, some comments expressed related directly or indirectly to Anderson's assumption.

Brief 4, when discussing Anderson's work, pointed out that future markets and prices were based on optimistic projections. It added that scanty attention to future markets had been given and that this was particularly so in the case of special crops. Brief 198 pointed out that the acreage of sugar beets, potatoes, vegetables, and dry peas was not expanding and that the growing of these crops did not warrant an expansion of irrigated acreage. The brief also stated that the production of wheat and barley was uneconomical on irrigated land except in the occasional year when prices were unusually high.

The Three Rivers Protective Association (brief 88) stated that they had repeatedly asked that market studies be conducted that would determine whether or not markets would exist for the increased production from new irrigated land. Their view was that no expenditure of public funds should be made until this had been demonstrated. They further stated that the proposed irrigation expansion could not be justified as a contribution to feeding the hungry world. They added that the competition between dryland and irrigated farmers was more pervasive than the Management Committee stated in their report.

The Municipal District of Pincher Creek (brief 100) suggested that during the time of near future development that the effects of increased production on markets be closely monitored, and that this be taken into consideration before far future developments were pursued.

Two dryland farmers (briefs 112, 118) from the western end of the basin maintained that any increase in production on irrigated land would adversely affect dryland farmers' markets, while another brief (120) questioned whether or not there was any market for increased production. One dryland farmer (brief 71) in an irrigation district argued that grain production on irrigated farms plugged grain handling facilities to the disadvantage of himself and other dryland farmers.

Irrigation farmers disagreed. Brief 92 stated that incremental increases in production which would result from expanded irrigation acreage would not affect markets adversely. Another farmer (brief 64) contended that rather than flooding the market irrigation farmers were creating markets by importing feed grain for their livestock industry and providing a market for ranchers' calves, yearlings, and cull cows. This view was supported by brief 61.

The Environment Council concludes that Anderson's assumption was reasonable. To the best of its ability, the Council has attempted to evaluate the risks involved in these predictions.

The greatest risk factor is the long pay-off period. Most structures are expected to last 50 or more years. The farther ahead one attempts to project the crop mix, costs, and prices, the greater the degree of error involved. The Environment Council believes that some projections for the next 10 or 20 years have considerable validity, but attempts to go beyond that, in most cases, leave the world of economics and enter that of science fiction.

The cost in 1979 dollars of major irrigation structures and distribution facilities can be estimated with some accuracy because they are once-only capital costs. Any errors in cost estimates for operation and maintenance will not likely be very significant. The other costs, those incurred by the farmer, are subject to a higher degree of error. These are largely annual costs subject to the vagaries of the market and to probable unknown changes in technology.

Historically, yields have gradually increased over the years. Two reasons suggest that this increase will be accelerated in the future. In the first place, present average yields are low in comparison with other roughly comparable irrigation areas. Secondly, they are low when compared to experimental areas and those of above average farmers. The techniques are available to increase the yields of most crops beyond historical trends. The probability of this happening seems reasonable. To the extent that it does, the margins between selling price and cost should increase.

When it comes to forecasting prices, the risk factor becomes very great, even in the short term. The only available basis is that of historical trends. Even if these trends prove reasonably accurate, extreme highs and lows appear inevitable because the price of wheat and feed grains are world prices subject to crop failures caused by nature as well as those caused by mismanagement by individuals and governments. In the near future, there seems reason to believe that Canada will remain a residual supplier of these products, coping with periods of surplus production and low prices, and periods of low production and high prices. The far future cannot be discerned.

The price of red meats and vegetables is largely determined by the North American market. Supply and demand are the primary determinants, but actions of government can and do influence the market from time to time. Here again, prices fluctuate widely, as even small surpluses cause substantial price declines. Attempts to overcome these problems by controlled production may have some beneficial effects in certain areas where it is possible to isolate the market area from imports. A more promising approach is for the producers to have available reliable market information on which to make decisions. It seems reasonable to conclude that the problems will continue to exist for some time to come. It also seems reasonable to conclude that price projections, no matter how sophisticated, have a high degree of risk in evaluating the economic viability of irrigation or any other type of farming.

What is a certainty is that food will not become passé. While the basis of food is the growing plant, the form in which it is consumed continuously changes. These changes are dictated by consumers on the basis of affluence, advances in nutritional science, fads, and the skill of entrepreneurs in marketing new food products.

Blakeslee, Heady, and Framingham (1973) have demonstrated that eating habits are directly related to disposable income. The extremes are the very poor who subsist on a bowl of cereal grain and perhaps a little fish, to the affluent steak and lobster eaters. Disposable income cannot be predicted with any certainty except in the very short term. No one predicted that following World War II incomes of the Japanese people would rise to the extent they did, and that the Japanese would become major consumers of bread wheat and, to a lesser extent, red meat. Similar advances in increased income and resulting changes in demand for food may well take place in other developing countries.

It can also be assumed with a high degree of certainty that the total demand for food will increase for a long time to come. Demand is directly related to population growth. Rate of growth in recent years has been very high, although there is some evidence that this is tapering off and is likely to decrease gradually during the next half century. On a world basis, it seems extremely improbable that there will be a decline in total population during the time frame being considered.

Many of the products grown on irrigated land are destined for use in Canada and more particularly in Alberta. The growth in demand will be proportional to the increase in population. Total growth in Canada is likely to be low. The Economic Council has suggested 1.1 per cent until 1985. All indications are that the growth in Alberta will be substantially higher—perhaps 2 per cent—at least in the near future.

In summing up, the Environment Council accepts Anderson's assumption as "most likely." The major risk factor is the long pay-off period inherent in irrigation development. In a shorter time frame, it is possible that yield increases will exceed historical trends. As to costs, prices, and profit margins, the best estimates are that they will follow historical trends. The main point of investment of public funds in irrigation projects, however, is deriving benefits from the marketing of production from irrigated land. Many people said that an ensured water supply would guarantee success. This is only partially true; every link in the chain between producer and consumer must be strong to guarantee that an ensured water supply will produce success. Therefore, in considering and promoting the development of irrigation, not only must production and market be assessed, but the crucial links of storage, transportation, processing, must be analysed and strengthened where necessary. It must be admitted that the risk factor in these projections is substantial. The Environment Council feels confident that farmers in the future will adjust crops grown to meet changing market demands and adopt as yet unknown new technology so as to remain competitive in the food producing industry.

5.3 CROPS AND MARKETS

In order to put the marketing of irrigated crops into some perspective, and to obtain evidence of the validity of the conclusions arrived at, inquiries were made into the prospects of some of the major crops. To do so, the Environment Council examined published reports and had discussions with a few of the major growers, some processors, and research personnel. The results of this rather cursory examination support the conclusion that there is potential for market growth in established crops and possibilities for new crops now coming into production. It should be emphasized that these, for the most part, were not in-depth studies and had the matter been discussed with a wider range of individuals, impressions might have been modified.

5.3.1 Forage, Pasture, and Feed Grains

Livestock feeds and forage occupy slightly more than half the irrigated acreage in the Oldman River Basin. This corresponds to the cropping pattern in many other irrigation areas. Even in the Imperial Valley, which is in the extreme southern part of California, the same proportion of forage and grain crops exists, even though the valley is known as the winter garden of America.

In the Oldman River Basin, alfalfa is a major crop. It produces good yields of high quality forage, high in protein content, and is especially important in the rations of growing animals. In addition, it improves the physical condition of the soil and adds nitrogen to it. A high proportion of the crop is either used by the farmer himself or is sold to feedlots. Depending on the dryland hay crop and the severity of the winter, substantial amounts are sold from time to time to dryland farmers in the surrounding areas. A portion of the crop is marketed to processors for the production of dehydrated and sun-cured pellets or cubes. Most of this material is marketed locally. Buyers can be assured of a high quality, and the nature of the material readily lends itself to mechanical handling. Although there have been limited exports, the Environment Council does not have an opinion as to the viability of the export market.

Barley is the major feed grain produced. It is suitable for growing in all parts of the district and is the best crop available for soils with a high salt content. Unfortunately, yields are low, especially when expressed in pounds of digestible energy per acre. While plant breeding programs can be expected to improve resistance to disease and lodging, yield increases are likely to be marginal. Price is normally determined by farm to feedlot negotiation and is based largely on supply and demand at that particular time. No statistics are available as to the amount of barley consumed on irrigated farms. There seems to be a general impression that more is used than is grown. The deficit is supplied by nearby dryland farmers.

Grain corn production is limited to those areas with high heat units and a very low level of salinity. Corn is particularly susceptible to salinity (McKenzie 1978). When it can be grown successfully, yields are higher than those of barley. It appears that grain corn is not likely to become a major livestock feed until production increases substantially. The present level of production is not sufficient to meet the industrial demand. The greatest use of corn is likely to be for livestock feeding through the use of corn silage.

A potential feed grain could be one of the new dwarf high-yielding spring wheats that have been developed by the CIMMYT organization for use on irrigated lands. Yields, particularly when compared on the basis of digestible energy, are much higher than those of barley. These wheats have a lower protein content and less desirable bread-making qualities than Canadian hard red springs. The reluctance of authorities to allow these wheats to be commercially produced appears to be the fear that they could become mixed with the hard red springs and damage the reputation of Canadian wheats on the export market.

Sorghums and various sorghum hybrids are being tested as feed grain crops, but it is not yet possible to assess their commercial importance. They require a relatively long growing season and high temperatures.

5.3.2 Livestock Production

In addition to forages and feed grains, considerable irrigated land is or can be used for pasture. It is readily apparent that the forage, feed grains, and pasture produced on irrigated land must be marketed as livestock, essentially beef cattle. Historically, this has been the pattern. Finished beef is the most important special crop in the irrigated area. Since the crops concerned occupy at least half the irrigated land, it seems desirable to try and assess the future of the beef feeding business. While recognizing that at some future time constraints on food supply may eliminate all meat products, this possibility need not concern us for some considerable time to come.

In making an assessment of beef cattle feeding, the Environment Council has relied on the work of The Meat Industry Research Services, on the views of the Alberta Cattle Commission, and on knowledgeable feeders in the irrigated areas.

The Meat Industry Research Services (1979) concludes that the demand for beef in Canada will increase because of two factors. The first is the increase in per capita consumption that is associated with rising incomes, and the second, to the increase expected in population growth. They estimate that the total annual increase in demand will approximate one hundred million pounds. Surplus production above this level would, of course, have a depressing effect on prices.

They note that the two major cattle-feeding areas in Canada are Alberta and Ontario. The comparative economic advantage of feeding in each area is largely influenced by the institutional framework within which Canadian feed grain prices are set. Principally as a result of statutory rather than compensatory freight rates being applied to export and domestic grain shipments, in times of tight grain supplies, a feed cost differential in favour of Ontario results. As feed is a major cost component in cattle-feeding enterprises, the overall comparative advantage moves to Ontario in these market conditions.

In times of ample grain supplies, lower feed costs and the overall comparative advantage lies with the Alberta cattle feeder. Present grain supply prospects are such that, for the next few years at least, Alberta will continue to hold the comparative advantage in cattle feeding vis-à-vis Ontario. They also note that because of tightening environmental regulations for commercial feedlots in Ontario, a substantial capital cost disadvantage occurs there as compared with feedlots in Alberta.

Analysis of cattle feeding costs in Alberta compared with the major U.S. feeding areas—the midwest corn belt and the Great Plains region—show that the Alberta industry is fully competitive with that in the United States. When the

Canadian dollar is trading at a discount to U.S. currency, the comparative advantage is accentuated. In light of these results, it seems probable that a major share of the projected one hundred million pounds increased demand in Canada will be met by Alberta feeders. In discussion with the Alberta Cattle Commission, Meat Industry Research Services, and a Montreal feed broker, the Environment Council was assured that the Montreal market would remain available to Alberta cattle for the forseeable future. In addition to the Canadian market, there are some possibilities of developing a limited export trade, but the Council has not found any consensus as to the possibilities in this area.

The above discussion applies to all Alberta and is not restricted to the irrigated areas. Particularly in the Black Soil Zone of the province, beef finishing is and can be expected in the future to fill a substantial amount of the grain-fed beef demand. They will provide competition to the irrigated farmers.

In the opinion of many Alberta cattlemen, the trend to the use of silage for finishing beef will improve the comparative advantage of Alberta *versus* Ontario, particularly when grain supplies are tight. The advent of mechanical equipment to harvest and feed silage has made this feed attractive. Barley and corn are the crops used. Feedlot operators have stated that the use of silage has reduced the cost of gains, and death losses have been lowered because there is practically no problems with digestive upsets. The move to silage feeding requires major capital investments in equipment and storage facilities. Impetus is thus given to the development of the larger feedlot. In many cases, feedlots purchase standing crops which they harvest and store. Little information is available on prices paid, but that information indicates the grower is doing better than he would if he harvested his crop and sold the barley. Good storage is expensive, and as a result assured yields are a definite asset.

While pointing out that there will be competition between the irrigated and heavier rainfall areas in operation of feedlots, it must also be pointed out that all feeders must compete for feeder cattle, not only amongst themselves but also from the feeders from Ontario and the United States. This competition will allow the cow-calf operator to obtain the best returns possible for his product.

It is to be expected that in the future prices for feeder and finished beef will continue to fluctuate with supply and demand as they have in the past. No one has yet found a way to tame the cattle cycle. Hopefully, more skilled management and access to more sophisticated marketing information will dampen the highs and lows.

Well-managed irrigation pastures can produce substantial quantities of beef. Wilson and Slen (1974) report that gains of yearling steers amounted to 700 pounds per acre. Pastures also yield good returns when utilized by milking cows. At the Hearings one farmer (brief 63) reported that he had used irrigated pasture in conjunction with his feeding operation. This enabled him to regulate the time his cattle would be ready for market.

Milk production is well suited to irrigation farming. Assured winter feed, good summer pasture, and a relatively mild climate are plus factors. Market growth for dairy products is slow. Increases in fluid milk consumption are essentially limited by local population growth. Processed products have roughly the same limitations, primarily because of the market-sharing arrangements that dairymen have entered into across Canada. Recently, increases in per capita consumption have occurred, but it is doubtful if this rate of increase will continue into the future. Export markets are severely limited by tariffs, quotas, and lack of comparative advantage.

Other livestock products, such as hogs and poultry, provide a market for feed grains. They are not important in utilizing roughage or waste products from irrigated farms.

The Environment Council concludes that the livestock industry will continue to absorb the forage and feed grain produced on existing irrigated land, and will expand at a rate at least equal to the projected rate of expansion of irrigated acres.

5.3.3 Soft White Wheat

Soft white wheat is used in the North American market for the production of pastry flour. In the Middle and Far East, Latin America, and other countries, this type of wheat is used for chapatis, noodles, and steamed products. These markets are increasing more rapidly than those for bread wheats. They are being supplied by the United States and Australia. The major U.S. production area is in Washington, Idaho, and Oregon.

Canadian production began on irrigated land in southern Alberta in 1925. A small acreage was grown under contract with a local miller to supply local demand. Acreage grew slowly to meet the growing market until it reached about 60,000 acres in the late 1960s. During the 1970s, acreage increased rapidly, reaching about 166,000 acres at the present time. Somewhere between 100,000 and 120,000 acres were grown under contract. There is considerable speculation as to where the balance was marketed. It has been suggested that some of the wheat was sold to the Soviet Union, some to aid programs, and some to feed mills.

All cultivars (varieties) have been imported from Idaho. No plant breeding work has been done in Canada. Despite this, growers are averaging something in excess of 70 bushels per acre and occasionally yields of 100 bushels per acre have been secured. With some effort in plant breeding and good agronomic practice, average yields of 100 bushels per acre should be readily attained.

Growing world markets do exist and Alberta can be competitive with other suppliers. The Environment Council has not examined long-term price relationships, but a spot check indicated that the difference between Australian whites and Canadian hard red springs was about 10 per cent in favour of hard red springs. With proper care and barring bad harvesting weather, the quality of Alberta white wheat is excellent. Trial shipments to Iran from the Alberta Grain Commission were well received. To capitalize on this expanding market, growers will have to produce consistent and reasonably large quantities. To interest exporters and buyers, export production should, at a minimum, be in the neighbourhood of 15 million bushels annually. This would require about 260,000 acres for export and domestic use. This level of production could likely be achieved if growers had an assured market. Available information indicates that some grain companies are interested. What is needed is discussion between growers' organizations and grain marketers, some risk-taking by both parties, and the co-operation of the Canadian Wheat Board. These are difficult but not insurmountable problems. The Environment Council has been informed that some discussions are underway.

The Environment Council suggests to the research people, both in the provincial and federal laboratories, that a modest plant breeding program could be expected to pay big dividends. It is quite possible that growers might be interested in contributing to the cost of such a program. In addition to spring types, consideration should be given to the production of winter types. The latter could be expected to produce higher yields. They could be grown on land from which a crop of barley silage had been harvested.

5.3.4 Oilseeds

Rapeseed, soybeans, and sunflowers are potential oilseed crops that can be grown on irrigated land. The major oilseed grown at present is rape. Only in the last few years has this crop been grown under irrigation. In 1978, 50,000 acres were grown. Average yields were about 45 bushels per acre and the price about $6.50 per bushel. Most of this was grown on contract for local crushing. Crushers like the assured high yields, good quality, and low transportation costs involved in getting their raw product from local irrigation farmers. It was suggested that up to 100,000 acres will be grown in the near future. One limiting factor is that rape cannot be grown in rotations involving sugar beets, as rape can serve as a host for nematodes.

The price growers receive will vary with the world price of edible oils. Because of low production costs and the consistent high yields, growers should be able to absorb periods of low prices without too much hardship.

Crushing in the area has a major advantage. It provides a stable source of vegetable protein for the livestock industry in the form of meal. The ability of the crusher to compete on world markets is constrained by the fact that the transportation of raw rapeseed to the seaboard is highly subsidized, but when processed into oil and meal, it is not.

It would appear that soybeans can be grown successfully under irrigation where heat units are high. Some success has been had with this crop in the Bow Island area (brief 163). It cannot be said that soybean production is competitive with that of the United States and Brazil because the shorter growing season results in lower average yields. There is considerable doubt that they ever will be able to compete in the world market, but there is a substantial domestic market that could be served. This market cannot be served until local crushing facilities are available. To warrant changes in rapeseed crushing facilities to accommodate soybeans would require a production of 30 bushels per acre on about 85,000 acres. Considerably more experimental work and grower experience is needed before such acreages can be expected. There is no reason to believe that this will not be achieved at some future date. Soybeans can be grown in rotation with sugar beets, and being a legume extract their own nitrogen from the air, reducing nutrient requirements and improving the soil.

New cultivars of sunflowers can be successfully grown in most irrigated lands in southern Alberta. Yields of 3,000 pounds per acre can be achieved, and the price at present is about 16 cents per pound.

What makes this crop attractive at present is the substantial demand for cholesterol-free edible oils. Large amounts of corn oil are currently imported to meet this demand, particularly in the manufacture of cholesterol-free margarine. Sunflower oil is also cholesterol-free. Only minor changes in rapeseed processing facilities are needed to process sunflowers. While there seems to be little substantial medical evidence to show any advantage for cholesterol-free oil, consumer demand is substantial and growing. The market should be able to handle the seed from about 100,000 acres.

Alberta Photographic Services

Sugar beets remain an important source of revenue from irrigated land.

5.3.5 Sugar Beets

Sugar beets have traditionally been the cash crop of the irrigation farmers. They have been grown since the first irrigation was developed by the Mormon settlers, who brought the crop with them (brief 23). The market for the sugar produced consists of the prairie provinces, and this is shared with beet growers in Manitoba. At present, about 36,000 acres are grown in Alberta. Future expansion will be limited to the growth of demand among consumers and industrial users.

While growth will be slow, sugar beets will continue to be an important source of revenue for growers and of considerable importance to many other people in southern Alberta (brief 54). While the industry is mechanizing, it is still a large employer of labour. The by-products, including tops, pulp, and molasses, are important in rations for livestock because they increase palatability and supply easily digestable energy.

5.3.6 Potatoes

Potatoes have been an important crop on irrigated land for many years. The recent acreages are in the neighbourhood of 10,000 acres. They have not shown a steady increase in acreage but yields have improved.

Some difference of opinion exists between producers, processors, and research officers as to the present state of the industry. Growers stated they feel they are fully competitive with any other growing area. Processors and research officers stated that while yields are improving they are still below those obtained in roughly comparable areas. They pointed out also that quality was in many cases inferior, primarily due to handling methods that caused excessive bruising and to poor storage conditions. It should be added that some growers are doing an excellent job. It can be expected that others will improve and some will drop out of potato production.

There are two potato markets. The fresh market is essentially western Canada. Alberta growers compete with those from British Columbia and Manitoba. All are aggressive marketers, and from time to time what is essentially interprovincial dumping occurs. While this is a tough market, Alberta growers should at least be able to hold their share.

The processing market consists mainly of granules and fries. These products are marketed in both the domestic and world markets. Growth could be very substantial if growers can improve their production and quality and processors continue to upgrade their plants and improve efficiency.

5.3.7 Field Beans

A small field bean industry has been established in the Bow Island area. The beans are sold on both the domestic and export market. Price fluctuates considerably, but on average this crop has been moderately profitable. Recent innovations, particularly close planting, promise increased yields and lower harvest losses.

5.3.8 Faba Beans

Faba (fava) beans are now being grown by a few growers, but they cannot be considered a commercial crop at this time. The chief characteristic of this crop is that the seeds contain about 29 per cent protein. Field tests have produced yields of 4,000 pounds per acre. At the moment, the price is 6.5 cents per pound. Markets exist in many countries, particularly in the Near East and Japan. The competition is primarily from Western Europe. The seeds are used for human consumption to increase protein intake. While the results obtained by growers to date have been encouraging and while it appears that a substantial market exists for their product, it cannot be stated with any certainty at this time that faba beans will become a significant crop on irrigated land.

5.3.9 Vegetable Crops

The production of vegetable crops in southern Alberta has not been a glamorous success story. That it survived at all is due to the enthusiasm of a relatively few growers and a very few research people. That it has some potential for the future is due to the experience that has been gained. It is not necessary to chronicle the very human story of this industry, but merely to point out that all concerned had to learn how and what to grow, and how to process and market in a time when the established North American vegetable industry was going through revolutionary changes.

Three important events have occurred in the vegetable industry. First, the advent of supermarkets made it necessary for the broker to be able to guarantee supply and quantity on a regular basis. Second, the advent of refrigerated trucks made all markets available to all growers. Third, the high cost of labour forced the growers into the use of expensive mechanical equipment that required large amounts of capital and a high degree of management skill.

Despite the obstacles progress has been made. Peas and sweet corn are now well established. Turnips not only supply the domestic market but are exported in significant amounts. The yields of carrots have been doubled in the past five years. Significant improvement has been made in the storage of root crops and onions, thus increasing the marketing season. Kale crops of excellent quality and good yields are now being produced. Growers and processors are beginning to understand each other's problems with the result that there is less confrontation and more co-operation.

The potential exists to increase the share of the Alberta market and to participate in its future growth. To accomplish this requires greater integration at the marketing level of Alberta's production into the North American market flows.

It also requires increased efficiencies at all levels. Some of this increase can be achieved by known methods, but economies of scale await the growth of the industry.

Even the most optimistic predictions of growth will not significantly affect the need for irrigated acres. Any growth will improve cash income, secondary benefits and will reduce the need of importing vegetables which now cost Canada about $100 million a year.

5.3.10 Other Crops

The preceding discussion of various crops that are or can be grown under irrigation is far from being a complete list of what is or might be grown. It does not include forage seeds, dry peas, or other pulse crops. Spices, herbs, vegetable or flower seeds, nursery stock, and many other crops that might be worthy of investigation were not considered.

5.4 THE ROLE OF GOVERNMENT

The Environment Council commends the Government of Alberta for its efforts to promote the processing industry. This supportive role is most helpful, but the actual production, processing, and selling of products is the joint responsibility of all those in the industry.

It is unrealistic to expect the federal government to protect the market for any product by tariffs or quotas. The pressures by urban areas to keep food prices low are so great that no government would consider any proposal except under the most exceptional short-term situations. Considering this reality, encouragement by the food industry to have the federal government negotiate easier access to foreign markets is a more pragmatic approach. The work in production research and economic analyses at their Research Station at Lethbridge has been of great value, and should not only be maintained but expanded to fill ever-growing needs.

5.5 COMPETITION BETWEEN DRY AND IRRIGATED FARMS

There is a degree of competition between dry and irrigated farmers in southern Alberta. Nevertheless, the Environment Council agrees with the Management Committee report that essentially they complement each other. Dryland grain farmers sell most of their product in the export market. Their competitors are mainly the farmers of the United States and Australia. Irrigation farmers sell relatively more on the Canadian market, and their competitors are mainly farmers in British Columbia, Manitoba, and Ontario. The complexity of the food industry dictates that all food producers are in competition with each other to a greater or lesser extent. This is why farm gate prices for food products are low as measured by return to labour or return to capital in all countries of the world.

To bolster these returns and seek a degree of self-sufficiency, most countries, including Canada, have complex programs to subsidize the farm industry. While some of these programs are long-term and reasonably stable, many are temporary and are usually political decisions to meet emergency situations. To determine whether on average the irrigation farmer receives a comparative advantage over the dryland farmer by subsidy programs would be time consuming and the results of little value in the policy recommendations on which the Environment Council was charged to comment.

5.6 CONCLUSIONS

The Environment Council concludes that Anderson's assumptions were reasonable. In fact, the Council is somewhat more optimistic to the extent that the yields of most crops can be expected to increase, and that the potential for change in the crop mix to higher margin crops exist. The Council was impressed with the ability and enthusiasm of producers and processors and their confidence in their ability to grow in volume and profitability. Even if the Council is unduly optimistic, the evidence seems clear that markets will not be a limiting factor in developing the incremental irrigation acreage that has been recommended. Constraints on capital and water will be limiting factors rather than markets in developing incremental acreages.

6. REHABILITATION

6.1 INTRODUCTION

The Environment Council strongly endorses the Management Committee's first priority: improvement of existing water delivery systems, irrigation practices, and land classification. This conclusion is common to much of the work which precedes the Management Committee report, particularly, that of McCracken (1970) and more recently in the Phase I material of the Oldman River study. The judgement reached in the main report of this latter study is: "The current water shortages which are inhibiting the expansion of irrigation in the Basin are due mainly to the deterioration of the Irrigation District's distribution facilities" (Alberta Environment 1976, v. 1, p. 81)

At the Public Hearings, all those who expressed an opinion on rehabilitation, strongly supported it and most felt it should precede expansion (briefs 2, 4, 5, 6, 8, 12, 13, 15, 20, 21, 26, 32, 41, 43, 45, 67, 71, 80, 82, 84, 85, 87, 88, 93, 94, 99, 100, 102, 104, 105, 109, 110, 112, 120, 124, 125, 128, 137, 138, 143, 144, 149, 151, 170, 171, 174, 180, 181, 185, 187, 195, 213, 225).

6.2 EFFICIENCY

Rehabilitation and efficiency are linked. Efficiencies cannot be improved without rehabilitation and would decline if rehabilitation were not undertaken. There is a range of views on what the efficiency concept means. The Environment Council decided to follow the Management Committee's choice of definitions and to use the approach in the Stanley/SLN (1978) report. Efficiency is the ratio of water diverted for irrigation to that ultimately transpired by plants or used to maintain a salt balance. Efficiency can be broken down as follows:

Reservoir storage efficiency (Es) the volume of water delivered from the reservoir to the delivery system as a percentage of the volume of water diverted from the streamflow to the storage reservoir;

Delivery efficiency (Ec) the volume of water delivered at the farm headgate as a percentage of the volume of water delivered to the conveyance system at the supply source (S);

Farm efficiency (Ea) the volume of irrigation water used by plants plus that evaporated from the soil plus that necessary to maintain the favourable salt content in the soil solution as the percentage of the volume delivered at the farm.

This leads to the concept of an overall irrigation efficiency (Ei) which is the mathematical product of the above three efficiencies.

$$Ei = Es \times Ec \times Ea$$

The efficiency consultant (Stanley/SLN 1978) found the overall irrigation efficiency in the Oldman River Basin between 1968 and 1974 to be about 31 per cent. In order to assess 1978 efficiencies, the Environment Council reviewed this with irrigation district managers, who suggested that efficiencies had increased to 35 per cent (Table 10).

Table 10

Water Use Efficiencies of Districts

(excluding reservoir efficiency)

	SMRID		SMRID		LNID		TID		RID		MID		UID		Aetna Leavitt Mtn. View		Basin	
	(68-74)[1]	(78)[2]	(68-74)	(78)	(68-74)	(78)	(68-74)	(78)	(68-74)	(78)	(68-74)	(78)	(68-74)	(78)	(68-74)	(78)	(68-74)	(78)
	West		East															
	%		%		%		%		%		%		%		%		%	
Delivery (Ec)	53	58	77	80	60	70	72	77	45	45	45	45	40	43	40	40	64	67
Farm (Ea)	50	54	50	50	44	49	58	65	40	47	40	40	35	35	35	35	49	51
Overall Irrigation Efficiency	27	31	38	40	26	34	42	50	18	21	18	18	15	14	14	14	31	34

(this excludes reservoirs—see text page 97)

1. 1968 - 74 information from Stanley/SLN 1978,

2. 1978 information from interviews with Irrigation District Managers. The basin figures are computed as weighted averages not only on the various efficiencies given for each district, but also on the acreages on district assessment roles.

Stanley/SLN felt it conceivable, eventually, to attain an overall basin efficiency of 68 per cent. The Management Committee could not accept this figure and judged 60 per cent to be more realistic. The Environment Council agrees with that judgement. This 60 per cent target was based on reaching a delivery efficiency of 80 per cent and a farm efficiency of 75 per cent (.80 x .75 = .60 or 60 per cent). Reservoir storage efficiencies were not considered a component of these calculations. Hence, the 60 per cent and 68 per cent figures do not represent a true overall basin efficiency, but rather an overall weighted average of individual district irrigation efficiencies.

The maximum reservoir efficiency attainable is probably about 87 per cent, based upon an annual evaporation loss of 3 cubic feet per square foot of storage area (SMRID 1978). Including this in the efficiency equation brings overall basin efficiency down to 59 per cent and 52 per cent for Stanley/SLN and the Management Committee respectively. For this discussion, therefore, overall irrigation efficiency does not include reservoir efficiencies above the diversion points.

In order to place this in perspective, Stanley/SLN reported efficiency information from 21 projects in 17 states of the western United States. The 1949 to 1960 data are:

Delivery efficiency	47.5% - 82.7%, average 63.1%
Farm efficiency	32.3% - 78.2%, average 59.3%
Overall (excluding reservoirs)	15.3% - 64.6%, average 37%

A March 1979 report in *Irrigation Age* indicated that the U.S. average irrigation efficiency for 1975 was 53 per cent and is expected to reach 59 per cent by the year 2000.

With the apparent shortage of water in the Oldman River Basin, it is understandable that efficiencies should receive considerable attention. The strong support for rehabilitation, which was identified earlier, was supplemented by the view that efficiencies were improving (brief 92), particularly with increased use of sprinklers (briefs 25, 54, 202).

Low efficiencies exacerbate two critical considerations in southern Alberta water management programs:

1. salinization of land through seepage from inefficient delivery systems and poor timing of irrigation; and
2. allocation of water among competing users.

Conversely, high efficiencies reduce salinity problems and provide more water for re-allocation.

6.3 SALINIZATION

The soil of southern Alberta is glacial in origin and is naturally high in salts. The occurrence of saline areas at groundwater discharge outlets, springs, sloughs, and areas with a high water table predates agricultural development of southern Alberta. The concentration of salts in the soils increase as water, but not the salts, evaporates or is transpired by plants. Eventually, salts accumulate to a level at which plant growth is affected. Alteration of the native grassland through cultivation, however, led to a marked increase in saline seepage to the point where "saline seepage is the number one soil problem in the Northern Great Plains Region" (Vander Pluym 1978, p. 1-48). In irrigated areas, salinization problems have been multiplied by losses of water from irrigation delivery systems (spillage, leakage, or seepage) and by poor, on-farm water management.

Differing views of the impact of soil salinity were presented in background material prepared for the Hearings and in briefs presented. Stanley/SLN (1978) estimated that "the total land area with salinized root zones in all Irrigation Districts of the Oldman Basin may comprise 174,500 acres; these saline lands include irrigated and dryland acres" (Sec. 2, pp. 16). This figure is a summation of acreages in Soil Classes III, IV, and V, but the report was unable to provide an accurate estimate of the acreage on which the salinization was irrigation induced. The report further points out that these Soil Classes are considered non-irrigable because of potential salinity. However, if permeability rates are high enough to allow natural drainage, or if drainage systems are installed, irrigation may be possible on some of these marginal lands. According to the report, crop yields on moderately saline land (Class III 0-2 Foot Root Zone ECe = 6) may be as much as 50 per cent below yields obtainable in salt-free root zones and with proper irrigation.

The Management Committee received input from the Irrigation Council, Alberta Agriculture, and Agriculture Canada, all of whom basically disagreed with the Stanley/SLN estimate of the extent of soil salinization and the effect of soil salinity on crop yields on irrigated land. The Management Committee recognized that severe salinization had resulted from canal seepages and improper irrigation and that these problems should be addressed more aggressively. It did not accept the Stanley/SLN estimate of the acreage affected. The Management Committee did not express a view related to crop yields other than to say that the impact on crop yield must be demonstrated to the farmer to assist him in making decisions. Within its recommendations, the Management Committee did not address the problem of soils salinization and effects on crop yields specifically, but rather made a number of recommendations (pp. 59-60) which suggested that more information was needed on the topic, and that an increase in related extension services to the farmer was also required.

The topic of salinization received much publicity prior to the Hearings and many participants commented on salinization and irrigation practices as well as local seepage and leakage from the water conveyance systems (briefs 2, 10, 12, 18, 20, 25, 37, 39, 41, 46, 53, 56, 58, 68, 70, 71, 73, 74, 92, 93, 94, 98, 153, 170, 174, 180, 188, 189, 203, 212, 226). In addition, the Environment Council received information from the consultants, government agencies, and from scientific reports.

6.3.1 Causes and Extent of Salinization

Salinization can be defined as the accumulation of soluble salts in the soil as the soil water, but not the salt, is removed by evaporation or transpiration. In irrigated areas, improper water management may increase the rate of salinization. Irrigation practices may raise local water tables, then capillary rise of saline groundwater and the evapotranspiration of crops will raise the soil salinity. As soil salinity increases, the osmotic gradient between the soil water and the plant cells increases and the ability of the plants to remove water from the soils decreases. Under this stress plant yields may decrease or, in the extreme, plant growth fails. Soil salinization can, therefore, have a wide range of effects, from the highly visible, total loss of useful productivity to "invisible," reduced, crop yield.

Several estimates have been made of the amount of salinized land in irrigated areas of Alberta. However, despite the extensive history of irrigation in Alberta, no properly designed survey has been done to determine the extent of salinization. Much of the past concern has been directed at visible salinity problems. The estimates below differ in the degree of salinization considered and the area examined and, therefore, cannot be compared directly. McCracken (1970) provided the following figures for "seepage affected" acreage in the various irrigation districts:

SMRID (West)	7,900
SMRID (East)	2,200
LNID	16,900
TID	2,500
UID	3,400
RID	6,200
MID	1,800
AID	700
LID	400
MVID	400
Total	42,400

Alberta Photographic Services

Early irrigation canals are still used in many areas.

Vander Pluym (1978) states that 200,000 acres, or 22 per cent of the irrigated lands in Alberta, are affected by saline seeps, but provides no details. Stanley/SLN (1978) estimates 174,500 acres of saline land in irrigation districts in the Oldman River Basin. Obviously, despite the variation in estimates, the productivity of substantial acreage in the irrigated areas has been affected as a result of soil salinization.

There are two main causes of salinization in addition to naturally occurring problems within the irrigation districts: first, and usually the most visible, is that caused by uncontrolled seepage along the water conveyance system; second, is poor scheduling. The relative contribution of each to soil salinization in the area is unknown, although Sadler (1962) is quoted in Stanley/SLN (1978) as estimating that 70 per cent of the salinization is attributed to canal seepage. Stanley/SLN commented, however, that there are now many saline areas away from canals and natural depressions, which are probably associated with shallow water tables due to deep percolation losses from irrigation where natural drainage is inadequate.

With conveyance losses in the Oldman River Basin averaging about 36 per cent, many areas along the distribution system where salinization is occurring are a direct result of leakage or seepage. This particular aspect received many comments at the Hearings. Several briefs (12, 20, 25, 37, 39, 46, 53, 56, 58, 71, 73, 93, 94, 170, 203) included a discussion of soil salinization related to the water distribution systems. Most of the briefs commented upon general canal seepage problems or about their particular local problems, but five briefs (14, 58, 93, 94, 226) made comments specifically related to the Monarch, Fort Macleod, and Keho Lake areas in the LNID. Three briefs referred to problems in the RID (20, 170, 195). Many other briefs expressed fears, based on past experience, related to seepage problems which might occur with expanded or new reservoirs.

Most of the problems of canal seepage in the LNID, RID, and in other older areas can be related to the level of technology available during the construction of the district. Many of the canal systems have changed little since they were constructed by manual labour assisted by horse-drawn equipment. Lack of adequate maintenance of the systems or an on-going rehabilitation program are also major factors contributing to poor conveyance efficiency.

The LNID estimates (brief 25) about 10,000 acres have been lost due to seepage or poor irrigation practices. This acreage has been taken off the roles and in some cases a permanent settlement has been made. In the last ten years, 3,100 acres of land have been reclaimed. According to three briefs (58, 93, 94), other people would like to have land removed from the roles of the irrigation district. Even if land is classified as non-irrigable and removed from the role, until the source of excess water is controlled, reclamation is pointless. The district has little incentive to rehabilitate seepage sections rapidly, since in many cases, compensation has already been paid in perpetuity or the land is ineligible for compensation since a Ditch Rehabilitation Plan has been accepted (see Section 2.4.3.).

The LNID (brief 25) considers that its first priority must be to guarantee the users adequate water and, therefore, more work is being done on capital works—laterals, drop structures—than on canal rehabilitation. At least one person in the Fort Macleod area (brief 14) also feels that that particular area does not receive its fair share of management attention because it is a lower value crop area. Even the recent changes in irrigation practices, sprinklers, which have helped control irrigation-induced seepage, may have brought problems. Brief 12 points out that to supply water to farmers on demand requires that the canal remain full at all times, and more seepage can occur as a result.

The problems within the LNID have been discussed in detail for a number of reasons: several briefs expressed concern and dissatisfaction with the operation of the LNID; of the major irrigation districts, the LNID has the greatest acreage of waterlogged or seepage affected areas; and the LNID is a major benefactor of the proposed water management schemes. Similar problems, however, occur in all the irrigation districts, and all seepage losses from the conveyance systems should be considered seriously from two points of view—efficiencies and soil salinization.

The Raymond Irrigation District, which was singled out as another area suffering major seepage problems, was discussed in three briefs (20, 170, 195). As well as the types of problems discussed above, the RID has its problems compounded by groundwater discharge, shallow bedrock, and seepage from Milk River Ridge.

The second cause of salinization is poor management of irrigation waters. On many flood irrigated farms, alkali or saline areas appeared which could be related directly to the use of irrigation. Flood irrigation did not provide an accurate control of the amount or distribution of water. Water, therefore, tended to pond in areas and create saline spots. With the advent of sprinkler irrigation, this has become less of a problem, although irrigation may locally raise the water table and create surface or subsurface outlet areas which become saline.

There is some debate about when and how under-irrigation could be a serious problem. It is a problem if, due to evaporation, salts accumulate in the upper profiles of the soil and are not leached out. However, irrigation water in the basin has sufficiently low salt concentrations that accumulation would be very slow and, hence, a long-term consideration. This area concerned Stanley/SLN and accounts for the differences between their estimate of irrigable land and that of Alberta Agriculture.

Stanley/SLN (1978) contends that some Class III soils are not suitable for permanent irrigation without drainage, since there is inadequate vertical permeability to allow sufficient downward leaching of salts. Alberta Agriculture supports the view that soils and irrigation practices in Alberta are different from those for which U.S. standards were developed, and that drainage is not the only solution.

Stanley/SLN further contends that crop yields on moderately saline, Class III soils (root zone ECe = 6) could be reduced as much as 50 per cent due to combined effects of salinity and improper irrigation. Experimental data included in the Stanley/SLN report supported the statement about yield reduction. For the purposes of determining the benefits of drainage and proper irrigation, the report estimated specialty crop (vegetables and potatoes) losses of 50 per cent, 50 per cent yield losses for alfalfa, wheat yields decreasing by 40 per cent, and yields of other crops, except barley, decreasing 30 to 40 per cent. Scientific reports and communication with Alberta Agriculture staff seems to support these conclusions although information is limited. This does not mean that crop production increases of 50 per cent or more are possible from all lands currently irrigated. Farmers tend to adjust their crops to the suitability of the soil, and areas of high salinity now produce primarily barley or are irrigated pasture as opposed to specialty crops and other salt sensitive crops. The Stanley/SLN comments may be most applicable to yield reductions on small patches of Class III or poorer soils under a centre pivot irrigation system. No comments were received during the Hearings concerning the effect of soil salinity on crop yields.

The Environment Council recognizes salinization as a serious problem for both irrigation and dryland farming in southern Alberta. Current work at identifying and removing salinity problems should continue. The disagreements between experts on the exact extent and source of problems should be resolved with reference to specific conditions and practices in Alberta.

6.4 WATER USE

Although the Water Balance Model estimates that there is adequate water available in the Oldman River Basin to irrigate 899,000 to 929,000 acres at current efficiencies, depending on the onstream dam chosen the Management Committee decided that 850,000 acres was a more appropriate ultimate limit (Management Committee 1978). Estimates of future irrigation demands were based upon existing water demand, extrapolated for the increased acreage. This existing water demand was addressed by Underwood McLellan (1978c).

Underwood McLellan used historical information (1967-75) to prepare seasonal water-use multiple-regression equations. This statistical technique correlated an irrigation project's water use, measured at the diversion point, and rainfall records. Hence, by reviewing earlier rainfall records (1912-1975), a prediction can be made about how much water would be required for irrigation. The projects used for this were the SMRID (East), SMRID (West), and LNID. Lethbridge and Medicine Hat were the weather stations used. Similar equations were prepared for the irrigation-use factor. This is the ratio of acres actually irrigated to the acreage listed on a district's assessment role.

With this information base, the Water Balance Model estimated water requirements for various expansion scenarios. In assessing the near and far future requirements, Underwood McLellan assumed:

1. water use per acre would increase by 15 per cent in the St. Mary Project, and

2. the irrigation-use factor would increase by 5 per cent in both the SMRID and the LNID projects.

Efficiencies were not part of the responsibilities of Underwood McLellan (1978c), but the report did suggest "that as facilities and techniques improve, the majority of irrigators will apply somewhat more water to their various crops, and that this trend will have a greater effect towards higher water use than factors such as improved efficiencies will have toward reduced water requirements" (p. 8). This statement was footnoted to identify that Stanley/SLN was preparing a separate report on the matter. The Management Committee accepted the water demand forecasting procedures of Underwood McLellan for the purpose of operating the Water Balance Model. Unfortunately, the model did not incorporate efficiency considerations from the Stanley/SLN report.

In terms of assessing strategies for meeting near and far future water demands in the Oldman River Basin, the above assumptions are critical. Depending on their validity, combined with judgements on expansion priorities (see Sections 7 and 8), very expensive structural alternatives can be accepted or rejected. The Environment Council wrestled with this problem and eventually decided the data available were inadequate for the decisions required. For example, there is no question that an increase in efficiencies makes more water available. The same diversion rate allows more land to be irrigated or results in a lower diversion rate per acre of irrigated land to deliver the same amount of water.

The absolute amount of water a district requires is, therefore, less until enough irrigation expansion occurs to offset increased water availability due to efficiency increases. An estimate can be made of how much expansion can take place before this crossover occurs for existing levels of diversions from headworks from information available in the Stanley/SLN (1978) and Underwood McLellan (1978c) reports. Hence, using

1. an LNID efficiency change from 26 per cent to 60 per cent;
2. an SMRID change from 33 per cent to 60 per cent;
3. a 15 per cent increase in water demand in the SMRID;
4. a 5 per cent increase in the irrigation use factor for both the LNID and SMRID; and
5. mean project water use and irrigation use factor information from Underwood McLellan (1978c, p.8),

this crossover occurs at about 540,000 acres in the SMRID and 239,000 acres in the LNID. Above these approximate acreages, an increased diversion is required by the districts to deliver the same amount of water per acre.

Much of the argument supporting an increased water demand per acre of irrigated land comes from the experience of the Taber Irrigation District. This district is generally considered to be further advanced in its rehabilitation program and irrigation practices than others in southern Alberta. From 1974 to 1977 the Taber District had a water demand averaging about 1.7 times that of the SMRID, suggesting that more mature irrigation districts utilize more water per acre of irrigated land.

Present irrigation application levels seldom reach the crop's physiological optimum. While this is true, Underwood McLellan (1978c) recognizes the economic reality of the decisions involved when discussing use of the regression equations. "Use of the above correlation is empirical and based on the premise that the mix of crops grown do not change significantly and that project operators and irrigators have established their best combinations of water delivery and water application consistent with available facilities, crop water requirements, and production economics" (p. 7).

There is a definite incentive for optimizing economic use of water with sprinkler irrigation equipment. The Secretariat of the Irrigation Council estimates that energy costs alone range from $8 to $15 an acre. The only conclusion the Environment Council could come to in this debate was that more water will be available as the rehabilitation program proceeds. The magnitude, distribution, and utilization of that increase is unknown, although such information is essential for sound future decision making.

6.5 THE REHABILITATION PROGRAM

To reach an overall district irrigation efficiency of 60 per cent, based upon 80 per cent delivery efficiency and 75 per cent farm efficiency, requires a substantial rehabilitation program. The components identified by the consultants, the Management Committee, and Hearing participants are:

1. rehabilitation of the existing delivery systems;
2. a scheduling system at both the district and farm level; and
3. metering of water to individual farms for better management and so that penalties could be assessed for non-beneficial or excessive use of water.

6.5.1 Delivery System Rehabilitation

The technology to improve delivery systems received specific comment in many briefs (25, 37, 42, 50, 58, 65). Techniques include concrete lining, piping, sulphurcrete, plastic lining and use of interceptor ditches, and drains. The argument that we should wait for a new technology must be rejected as the present inefficiency costs are too high. In addition, the 53 briefs supporting rehabilitation as a top priority indicate a growing public pressure for rehabilitation as a precondition for expansion.

The cost of a rehabilitation program is dependent on the level of sophistication required. This varies with location and considerations of soils, crop mix, and the district objectives and desires. The Environment Council met with experienced irrigation district staff in order to obtain a cost estimate.

Irrigation district staff pointed out that it would be impossible at this time to make any kind of total estimate because the desired level of rehabilitation depends on the level of cost sharing, topography, soils, and many other factors. Recent experience indicates that the cost of concrete-lined distribution canals with underground pipe outlets would be about $300 per acre. However, small, especially difficult areas would cost more. Many other areas would cost less because not all canals require concrete lining. To further compound the problem of estimating costs, it is difficult to determine how much of the system or portion of the districts is already rehabilitated. A guess would be that the total remaining cost would be $100 million to $160 million for the Oldman River Basin. This does not include the cost of rehabilitating main canals.

The above projected levels of expenditure are very large. However, the Environment Council feels it has no alternative but to recommend the necessary funds be expended to bring existing irrigation works up to a reasonable standard. The question arises as to what is a reasonable standard. Such standards should be established by the Irrigation Council recognizing the objective of reaching an overall delivery system efficiency of 80 per cent by the year 2000. In some locations, it may well be economic and desirable to have the structural part of the program exceed the Irrigation Council's minimum standards. Where this should occur is best decided by the farmers concerned.

The cost of rehabilitation within a district is now shared on an 86/14 basis. The Environment Council believes cost sharing should be continued, but on a 75/25 basis. This would eliminate the need for provincial rationing of rehabilitation funds. The farmers, through their district boards, would decide the desirable level of rehabilitation, subject to the approval of the Irrigation Council. The provincial government would undertake to supply their share of the capital on demand. This approach suggests substituting self-discipline for bureaucratic restriction and substituting elementary market discipline for capital rationing. In order to facilitate the change, the following schedule is recommended:

1980, government 82 per cent, districts 18 per cent
1981, government 78 per cent, districts 22 per cent
1982, government 75 per cent, districts 25 per cent.

Some restriction must be placed on the time taken to complete this work. The Environment Council believes that making the provincial share of capital available on demand should speed up the process, and that techniques to increase the working season can be devised by innovative engineers. Differences among districts make it unrealistic to expect all to finish within the same time limits. Hence, the Environment Council recommends that each district decide how quickly it can complete its program and, subject to the approval of the Irrigation Council, that this be the termination date. In no case should this be later than 1995. The situation may arise where a farmer, or group of farmers, desire rehabilitation works to a higher standard than the district is prepared to accept. In this case, the district would be free, as it is now, to make whatever cost-sharing arrangement seems appropriate.

The Management Committee estimate for rehabilitation of the SMRID Main Canal downstream from Milk River Ridge Reservoir is $40 million. These works are part of the district's delivery system and though subject to cost sharing are beyond the ability of the district to pay. In contrast, the $45 million estimated cost to rehabilitate the LNID Main Canal and the $24.0 million cost for the construction of the Mud Lake Reservoir is an Alberta Environment responsibility, as the headworks extend to the outlet of Keho Lake. Headworks south of the Oldman River should include the SMRID Main Canal downstream, including Sauder, Chin Coulee, and Forty Mile Reservoirs. Defining the headworks in this way gives Alberta Environment responsibility for the major delivery and offstream storage systems in the basin. The SMRID would no longer face the associated rehabilitation and maintenance costs and the other irrigation districts served by that system no longer need to contribute to these expenses. The Environment Council recommends the districts be charged a wholesale water charge of 50 cents per acre foot of water diverted from these newly defined provincial headworks.

This recommendation is designed to meet three objectives; first, to emphasize the value and to ensure the careful use of water; second, to provide an additional incentive for accelerated rehabilitation programs; and third, to create an efficiency fund to assist innovators and researchers to develop new irrigation technology appropriate to the land and climate of southern Alberta and to recognize a broader level of provincial service.

The first two objectives need no further comment.

The third deserves further explanation. Much of the technology for water conveyance and application to our soils has been imported. This has come about because our irrigated acreage has been small and capital resources have been used for what was judged to have higher priority. The Environment Council believes that the time has come to provide opportunities to move into these areas. The cost of rehabilitation will be very high as well as the cost of developing incremental acres. The only hope of keeping these costs from escalating and keeping the farmers competitive with other food producers is by applying innovative technology to reduce costs. Less costly techniques would not only benefit existing irrigation areas, but might make it economic to use supplemental irrigation in other areas both inside and outside Alberta. Also, the Council is not unmindful of the possibilities that would exist for exporting technology and machines that might be developed. Alberta has matured to the point where it has experienced and innovative engineers, farmers, companies, and academics. Given financial assistance and encouragement, a high success rate should be possible.

To accomplish this, the Environment Council recommends that the following be implemented:

1. that the fund created by the 50 cents per acre foot wholesale charge for water be administered by the Planning and Research Secretariat of Alberta Agriculture;
2. proposals falling within the guidelines may be made by anyone, including individuals, companies, irrigation districts, producer associations, or universities;
3. that these proposals be submitted to the Irrigation Council for appropriate comment;

4. the Irrigation Council would forward the proposals to the Planning and Research Secretariat who would access the necessary expertise to evaluate the proposals and would advise the Irrigation Council of their approval or otherwise;
5. when funds are available, the Irrigation Council and Alberta Agriculture would publicize the existence of the fund and the guidelines for its use.

The guidelines in order of priority would be as follows:

1. To deal with matters pertaining to the efficiency of water use. They would include, but would not be limited to; water conveyance, water application to land, reservoir and storage loss prevention, drainage, waste disposal, and automatic control devices. The Council envisages that proposals might be forthcoming on new materials for canal linings, the testing of large diameter pipe, developing machines for applying water that would require less energy or would result in less loss due to wind. Similarly, someone might develop new methods or machines that would provide cheaper and more efficient drainage.
2. The Council believes that initially some of the fund should be used to install necessary measuring devices to establish a data base on water use. Once the base was established, its continuous upgrading would be the responsibility of the appropriate administrative units.
3. Proposals dealing with the storage, processing, and marketing of existing or new crops would be eligible for funding.
4. Producer associations would be eligible to present proposals and receive funds to match those from the Agriculture Research Trust Fund to meet particular problems. An example might be a plant breeding program to produce more suitable soft white wheats. Production research has been given a low priority, not because it is not important, but because it is the responsibility of the federal and provincial governments to provide production research services to irrigation farmers just as they do to all other farmers.

While the Environment Council envisages many proposals will be related to rehabilitation, it should not be used to supplement normal rehabilitation program expenditures. Rather, its purpose is to encourage innovation for developing a more efficient and modern system of water distribution.

This charge is not recommended for the Foothills Districts because improved efficiencies in these districts is not a feasible proposition nor are any major additional expenditures for headworks contemplated. A charge for private irrigators is not practical due to the difficulties of measurement and enforcement.

6.5.2 Scheduling

The objective of scheduling is to match water deliveries with water demands on an optimal basis. When properly done, there should be few system spills, little return flow, and little loss of water to deep percolation. Surprisingly, this aspect of improving efficiencies received little comment at the Public Hearings. Those briefs received were in support (12, 20, 99, 152, 198) and pointed out that consideration must be given to both soils (briefs 12, 152) and ensuring that irrigation districts have the legislative power to control the flows of water through the system and to individual farms (brief 99).

6.5.2.1 District Scheduling

The benefits of scheduling at the district level are substantial and include:

1. more efficient use of water conveyance and distribution systems;
2. reduced diversion and pumping requirements;
3. reduced probability of unanticipated district shutdown due to water shortages.

With scheduling, more water becomes available for irrigation and, because water is distributed more efficiently, the design criteria for the distribution system can be reduced. By matching supply to farm demand, less water is spilled and reduced salinity problems can be anticipated.

Implementing a district scheduling service at a level which will assist in reaching the 80 per cent delivery system efficiency objective requires both structural and administrative components:

1. water demand forecasting capability;
2. good operational information from the critical operating points in the system, including metering at the farm gate; and ultimately,
3. installation of automatic control devices for major components of the delivery system, preferably operated from a central location. The time and dollar costs of establishing such a system are unknown, but certainly the capital costs of metering and the automated control devices alone will be substantial.

6.5.2.2 Farm Scheduling

Farm irrigation scheduling has benefits in addition to those accruing to the district. An irrigation farmer will be able to utilize his resources of capital and water more effectively. He can also expect an increase in crop yield and improvement in quality. A preventative aspect also occurs in that reduced leaching of plant nutrients results, thereby reducing fertilizer requirements. There is also a reduced requirement for drainage and subsequent disposal of saline water.

The operation of a farm scheduling program which will help to reach the 75 per cent farm efficiency goal requires a sophisticated understanding of soil moisture relationship within a soil-crop-climate context. Stanley/SLN (1978) feels the data required for decision making includes:

1. the current level and expected change in the available soil water for each field during the following 5 to 10 days;
2. the expected latest date of the next irrigation for each field to avoid detrimental plant-water stress, and earliest date to permit efficient

irrigation and avoid over irrigation;
3. the amount of water to be applied on each field, if the irrigator is able to determine and control the amount;
4. some indication of the adverse effects of irrigating too early, too late, or perhaps terminating irrigation.

Extensive use of weather forecasting for farm scheduling is required, which is also true for district scheduling.

Alberta Agriculture has operated a generalized scheduling service for southern Alberta, which has been of value to farmers, particularly by introducing them to the advantages of using this management tool. However, it is beyond their resources to give the individual timely information that many farmers require.

The Environment Council perceives the role of Alberta Agriculture to research the complex interrelationships of scheduling, salinity, and soil fertility. The results of these investigations should continue to be available to farmers and to individuals or companies advising farmers.

Equity suggests that when a farmer needs individual scheduling services beyond that normally supplied by Alberta Agriculture, he should pay for them. This seems to be a service best supplied by individuals or companies in the private sector. One firm is already providing individual scheduling services at Lethbridge, and one at Brooks is working in the area of salinity determination and is contemplating a scheduling service. The Environment Council was pleased to find that both reported that Alberta Agriculture was most helpful and had given them complete co-operation and encouragement.

6.5.3 Metering

Many Public Hearing participants expressed the view that metering water delivered to the farm was an important component of the basin water management program (briefs 6, 20, 88, 93, 124, 125, 137, 153, 189, 198). They felt more efficient water use would result, particularly, if there were a price levied which was based on the quantity of water used (briefs 4, 88, 124). This position can be supported by pointing out the lower use of water in cities with metering programs than in those without (Kitchen 1975; brief 82). The value of metering was recognized by the Management Committee as part of its program requirements to reach 80 per cent delivery system efficiency and 75 per cent farm efficiency. At the district level, the major advantages of metering are to provide information for maximizing the effectiveness of the scheduling service and for evaluating where improvements are necessary.

Accurate flow measurement at the diversion and release points could also improve the evaluation of the rehabilitation programs and permit rapid identification of problems as they develop. With improved evaluation techniques, the opportunity for prudent future investment would increase.

The major advantage of farm metering is that it enables the use of economic incentives to discourage inappropriate water use, and should also assist in raising the consciousness of society about the value of water. As with the district, metering provides the farmer with operational information for day-to-day decision making.

The Environment Council feels another major benefit is possible from the metering program. This benefit is the information which could be made available to future decision makers. A serious problem faced by both the Management Committee and the Environment Council was the quality of information on which recommendations had to be based. Future crop water demands and water availability from efficiency change are particularly difficult to estimate, although such information is critical in assessing the many alternatives available to expand irrigated acreage.

The cost involved and limitations of technology may make the initiation of a complete farm and district metering program impractical at this time. An alternative is a staged program. This approach has the advantage of providing for a continued evaluation of progress. As information from the metering program becomes available, the program can be improved.

The initial program recommended would include metering at the major operation points in the Lethbridge Northern Irrigation District (for example, the Turin headworks, Monarch Lateral headworks) and in the St. Mary River Irrigation District (delivery points to the smaller irrigation districts and reservoir inflows and outflows) and metering at selected farms representative of the basin's variability. The benefits of a metering program accrue to the landowner, the irrigation district, and senior administrative groups (particularly those involved in the South Saskatchewan River Basin Study). Aid for metering should be available on the same cost-sharing basis as other elements of the rehabilitation program.

Dixon Thompson

The western end of the basin provides a diversity of habitats.

6.6 MAJOR CONSIDERATIONS

The dramatic structural costs of rehabilitation are either irrigation district costs, under the cost-sharing formula, or direct provincial government responsibility. When combined with the associated storage requirements (see Sections 7 and 8), the estimated capital costs in 1978 dollars (figures in millions) are:

Facility	Province	Irrigation farmer	Total
Delivery system rehabilitation (75/25 cost sharing)	$75-120	$25-40	$100-160
Main canal enlargement and rehabilitation			
SMRID	40	-	40
LNID	45	-	45
Reservoirs			
Keho	6	-	6
Mud	24	-	24
Forty Mile	36	-	36
Chin Coulee (tentative)	32	-	32
Total	$258-303	$25-40	$283-343

These costs do not include the construction of Sauder Reservoir (if required), or any rehabilitation which Alberta Environment may be required to do on existing headworks upstream from Milk River Ridge Reservoir.

The rehabilitation program in the Oldman River Basin does not create storage. However, by increasing flow capacity and rates, and by reducing water losses, more water does become available. Of equal significance is the land which can be returned to the productivity level present before seepage salinity damage occurred.

Provincial funds have been allocated to rehabilitation programs in the past. The recommendations presented here are for major expenditures in order to reach satisfactory efficiency levels throughout the basin. When this program is complete, all provincial funding to the irrigation districts should cease. The districts should then be solely responsible for the operation, maintenance, and replacement of their irrigation works. Alberta Environment would necessarily remain responsible for headworks rehabilitation.

7. IRRIGATION EXPANSION SOUTH OF THE OLDMAN RIVER

7.1 INTRODUCTION

It is commonly felt that a river basin should be considered in an integrated fashion. In most cases and places, this is sound advice. Both sides of the river contribute runoff to the main stream and land uses on both sides have substantial impacts. However, from the point of view of irrigation in the Oldman River Basin, there is a real dichotomy between the north and south sides of the river. Irrigation districts on the south side of the Oldman River use water exclusively from its southern tributaries, the Waterton, Belly, and St. Mary Rivers, and do not use Oldman River water. The return flows from irrigation, of course, go into the Oldman River, with important implications for quality. Surplus water is spilled from the reservoirs on the Waterton and St. Mary Rivers, and Milk River Ridge with implications for the stream flow on the Oldman River. During very dry years, water may be released from the St. Mary Dam to maintain stream flows at Lethbridge for domestic purposes. There are important relationships between the St. Mary system and the Oldman River, but basically any water used in the St. Mary system for irrigation or recreation purposes is water from the southern tributaries of the Oldman River, not from the river itself.

7.2 SOUTH OF THE OLDMAN RIVER

In referring to irrigation south of the Oldman River, three terms will be used: St. Mary system—all irrigation districts and works south of the Oldman River; St. Mary Project—irrigation districts lying below St. Mary Reservoir, including Magrath, Raymond, Taber, and St. Mary River Irrigation Districts, and the Blood Indian Reserve (see Section 12.2); Foothills Irrigation Districts—Mountain View, Leavitt, Aetna, and United Irrigation Districts.

7.3 FOOTHILLS IRRIGATION DISTRICTS

In 1977, the three small districts (Mountain View, Leavitt, and Aetna) had 11,231 assessed acres on their rolls, with 123 users. The United Irrigation District was comprised of 33,617 assessed acres and 180 water users. Collectively, these districts represented 44,848 assessed acres and 303 water users.

The Foothills Districts are characteristically marginal irrigators, although there are individual exceptions and pockets where this does not apply. Rainfall tends to be relatively high in these districts, and the land is quite productive under dryland conditions. The Foothills Districts receive over 11 inches of rain during the growing season of April to August.

Irrigation efficiencies are extremely low, about 14 per cent, and water rates are also low, ranging in 1978 from $1.50 to a high of $3.25 per acre. Farmers in these districts, with notable exceptions, are marginal irrigators. It is possible to be concerned with the low efficiencies and low water rates and to identify ways in which these might be improved by, for example, consolidating these districts with each other or with the St. Mary River Irrigation District. Consolidation would provide access to skilled professional management which would be able to indicate ways in which efficiency might be improved.

However, the existing districts are scaled and staffed to their level of interest in irrigation. Collectively, in spite of the acres involved, and their low efficiencies, they are not very heavy water users and their water demand usually arises in the spring when supplies are plentiful. There is very little irrigation expansion proposed for these districts and increases in irrigated acreage should not be encouraged. The Public Hearings generated little interest in the Foothills Districts. Local irrigators did not feel that they had many problems, and such problems as they had were little affected by water management in the Oldman River Basin. A policy of "benign neglect," at least in the short term, seems appropriate. Rehabilitation works and costs will be modest, and water savings not substantial. When water from the St. Mary system is fully utilized in the future, it might be desirable to encourage the purchase of water rights in the Foothills Districts by farmers who wish to irrigate in the SMRID. The Environment Council makes no recommendation for a mechanism to do so since it seems not to be an urgent problem, but something to be explored, and if a suitable method of transfer can be developed between the districts, it could lead to a more effective use of water in the future.

7.4 ST. MARY PROJECT--MAGRATH AND RAYMOND IRRIGATION DISTRICTS

In 1977, the Magrath Irrigation District had 9,480 assessed acres and 125 water users, while Raymond Irrigation District had 31,625 assessed acres and 235 water users. The rainfall is lower than in the Foothills Districts with Magrath having between 10 and 11 inches while Raymond experiences between 9 and 10 inches during the growing season. The longer frost-free period also provides a better opportunity for irrigation farming. The Raymond District, however, has extensive acreage which experiences underground seepage, complicating irrigation.

These districts are transitional from the Foothills Irrigation Districts where irrigation is marginal, to the St. Mary River and Taber Districts where irrigation is fully developed. Efficiencies in these transitional districts are low: 18 per cent in Magrath, 21 per cent in Raymond. Water rates are also low: in 1978, $5.00 per acre in Raymond; $4.00 per acre in Magrath. Specialty crops are not important, only 5 per cent of the Raymond acreage being devoted to them.

Irrigation will remain important in these districts and more water users will become effective irrigators in the future. It seems logical for these districts to be joined to the SMRID, or consolidated, to provide for better technical management and to improve their poor efficiency records, even though, for practical reasons, consolidation will be difficult. Efficiency levels such as these districts exhibit should be improved as water becomes increasingly scarce on the south side of the Oldman River Basin. Certainly with the low levels of efficiency, no encouragement to expansion should be considered, particularly when, as will be noted later, more suitable land for irrigation is available to the east.

7.5 TABER IRRIGATION DISTRICT (TID)

Taber Irrigation District is the most mature irrigation district in the Oldman River Basin. In 1977, TID had 68,178 acres of land on the assessment rolls with 432 water users. Historically, irrigation was begun early and the soils, climate, and topography all make irrigation the most appropriate use of the district's land base.

The success of the TID in irrigation agriculture can best be judged by reference to Anderson's (1978) cost/revenue calculations, based on crops and yields in each irrigation district during 1974 to 1976 inclusive. His prices were based on those prevailing in the 1973 to 1976 period, with adjustments to give more weight to prices during 1975 and 1976 when cereals were not relatively so valuable.

On the cost side he identified elements such as:

1. purchased goods and services—seed, fertilizers, sprays, sprinklers and machinery, crop insurance, and so on.
2. depreciation on machinery and farm buildings.
3. salaries and wages. He assumed that the irrigation farmers wages were $10 per hour. For example, for potatoes he calculated that 23.5 hours per acre of potatoes were required, with a labour cost of $235 per acre.
4. real interest, which is the cost of borrowing for mortgages and operating capital.
5. land taxes and water fees.

For the TID, the average gross revenue per irrigated acre was $281.44. The costs associated with this revenue, including $10 per hour for the farmer's labour, were $202.25 per acre.

On average, the surplus remaining to the irrigation farmer in the Taber District was $79.19 per acre after all costs have been calculated, including a return to labour. This is an average figure, calculated on the basis generally of the 1973 to 1976 experience. There have, of course, been poorer times for irrigation farmers, and an average disguises the fact that some farms made less than $79.19 per acre while others made more. When all costs have been accounted for, including an allowance for labour and management, the surplus that remains is identified by the economist as rent. Rent can be thought of as a surplus which is created by exogenous circumstances such as location, soil quality, or, in this case, water.

Some of this surplus gets capitalized into land value. Irrigated land in the Taber District is worth $243 per acre more than similarly located dryland, an increment of 110 per cent on dryland values (Anderson 1978, p. A-56). A concern raised at the Hearings (briefs 4, 37, 58, 71, 79, 88, 144, 145, 146, 206) was that this surplus was due to the high level of subsidization by the provincial government, or alternatively because water charges were too low.

In a free market, a surplus normally does not last long. But the irrigator enjoys a quasi-monopoly. Irrigated land cannot readily be expanded so that the surplus can dissipate among new entrants. Instead, part of the surplus becomes capitalized in the incremental value of land, over and above dryland values.

The provincial government, owner of the headworks and supplier of the water, does not try to claim the surplus and does not charge for the water it provides. Within the district, the recipient of the surplus is the one who sets the water rates. He can, therefore, shield himself from an attempt to appropriate the surplus.

This leads to several conclusions.

1. Irrigation in the Taber District is productive, efficient, and profitable.
2. Surpluses exist which indicate that irrigation farmers could pay more for water.
3. The size of the surplus reflects the subsidization of irrigation farming by the provincial government.

The last two points are two sides of the same coin. If more were paid for water, provincial assistance would be lower, or if provincial assistance were lower the surplus would be smaller. The recommendations of the Environment Council in this regard are contained in the section on rehabilitation. It is important to note that the Environment Council does not recommend that all the surplus be eliminated. Profit or surplus is a powerful driving force leading to investment and efficiency. However, the people of Alberta are being called upon to invest massive sums in irrigation. Such levels of investment are warranted when they create substantial benefits to the economy. It is quite clear that such benefits are being created. What seems to have happened is that the distribution of benefits has been miscalculated. The 86/14 cost-sharing split was based on the belief that about 11 per cent of the benefits of irrigation went to the primary producer with the remainder to local, provincial, and federal levels. The studies upon which this conclusion was based were conducted for ARDA in the 1963 to 1967 period, primarily to identify an appropriate cost sharing between the federal and provincial governments. Anderson's recent studies show that 40 per cent of the benefit of investment in irrigation is received by the primary producer while the remainder flows to the regional, provincial, and national level, through irrigators' purchases and production and the multiplier effect. Anderson's work benefits from better data that have accumulated over the last decade and from input/output tables that have been prepared. His estimations of the distribution of benefits is felt to be more accurate and is one of the considerations for the suggested revision of cost sharing discussed in Section 6.

The other districts have similar, though smaller, surpluses, using the same approach as described for Taber:

SMRID (East)	$ 33.92
SMRID (West)	$ 53.25
LNID	$ 49.31
Raymond	$ 42.69
Taber	$ 79.19

The basic reason for the superior performance of Taber is probably the high concentration on specialty crops, (sugar beets, potatoes, vegetables, and grain corn) with 28.4 per cent of the acreage in such crops. In SMRID (East) only 11.6 per cent of the acreage is in such crops, while comparable figures for other districts are:

SMRID (West)	17.5 per cent
LNID	9.4 per cent
Raymond	5.0 per cent

7.6 ST. MARY RIVER IRRIGATION DISTRICT

The SMRID is the largest irrigation district in southern Alberta with 274,301 acres of land on the assessment rolls, and 1,537 water users. The district is so large (it stretches from Lethbridge to Medicine Hat) that it has to be broken down into smaller units to provide a more accurate description of its characteristics.

7.6.1 SMRID (West)

SMRID (West) is basically that part of the district west of Chin Coulee Reservoir. This is a mature district with irrigation in the Lethbridge-Coaldale area dating back to the beginnings of irrigation in southern Alberta. These are experienced irrigators who have shifted towards higher value crops which take expertise to grow successfully. Parts of the district suffer from old and inadequate distribution systems, particularly those built by farmers themselves and not taken over by the district. These distribution systems certainly deserve early rehabilitation since soils and climate are excellent for irrigation and surpluses generated here are high.

7.6.2 SMRID (East)

SMRID (East), an area basically to the east of the Taber District, is a relatively recent addition to irrigation in southern Alberta as it has only been under irrigation for a little more than 20 years. The area has excellent irrigation soils, with the highest heat units to be found in southern Alberta. It has been said that it takes three generations to create a mature irrigation community. Certainly with the advent of sprinklers, the length of time to learn irrigation farming has been shortened. Nevertheless, it is a complicated and specialized type of farming. Because of the intensity with which land is used, each farm and farmer must become thoroughly familiar with the reaction of his particular soils and slopes to water applications. The response of crops to water applications, given the nature of the local climate, must also be learned. Finally, in these Brown Soil zones there is normally a basic deficiency in organic matter which must be built up through cropping over a number of years. All of these things mean that there still remains an extensive learning curve which may not be three generations any more but is certainly longer than one generation. The low level of surplus and the low representation of specialty crops in SMRID (East) do not reflect a basic incompatibility for irrigation farming. Physically, in terms of soil, climate and the differential between intensity and incomes under dryland or irrigation farming, this is potentially the most attractive irrigation area in southern Alberta. There was support for expansion in eastern areas of the SMRID, not only from the local areas (Bow Island and Medicine Hat), but also from dryland farmers in the western end of the basin. This support was based on the low carrying capacity of the land in a dryland state, the high heat units and the potential to grow the full range of irrigation crops suitable to southern Alberta.

7.6.3 The Highline Proposal

With regard to expansion potential two alternatives have been proposed. Expansion adjacent to the existing main canal system (the Lowline Proposal) or expansion by way of a new canal system to the south of the existing canal, running north of and generally parallel to Chin Coulee (the Highline Proposal). The two systems converge to the east of Forty Mile Coulee. Physically the Highline Proposal, which Underwood McLellan (1978d) examined in three variants for the St. Mary River Irrigation District, is feasible. However, their estimate is that the cheapest of the highline alternatives would be about $100 per incremental acre more than expansion associated with the lowline development (Highline $574 per incremental acre, Lowline $479 per incremental acre).

However, the basic limitation in SMRID (East) is not soils suitable for irrigation, or the high cost of district distribution systems, but water availability on the south side of the river.

7.6.4 Limits to Expansion

There are two principal factors which limit irrigation expansion in the St. Mary Project, economics and the physical limits of available water. Within overall limits of physical availability, the amount of water can be increased, but only at some increase in cost. The critical question is, then, how much increased acreage at what cost. There are essentially two possible scenarios, one with only gravity fed irrigation systems and the other with gravity systems supplemented by pumping with the Chin Pump.

Alberta Photographic Services

A wheel-move sprinkler system.

Pumping water at Chin is extremely expensive. At present, the energy cost per acre foot pumped is $8.16 (408 Kwh per acre foot)(Klohn Leonoff 1978a). To provide 1.5 acre feet of water at current efficiency levels in the SMRID (East) of 40 per cent would cost $30.60 per acre. At 60 per cent efficiency levels, equivalent energy costs would be $20.40 for 1.5 acre feet of water. However, it is difficult to believe that in the future increases in irrigation efficiency will outpace the rising real cost of energy. In addition to the energy costs which are high and are likely to continue to rise, pumps and pump structures are depreciating assests which need to be replaced.

At the estimated capital cost of about $19.0 million for the Chin Pump (Klohn Leonoff 1978a), there is an annual operation and maintenance cost of $168,230 and an annual depreciation for structural and electrical/mechanical equipment of $535,600 (Appendix 7). These total fixed annual costs of $703,830 would have to be spread over the acre feet pumped or the acres served. At 105,759 acre feet pumped (which is the mean annual volume pumped estimated by Acres for model run 211-1A), these charges would be $6.65 per acre foot. At 40 per cent efficiency, this volume would provide 1.5 acre feet to 28,202 acres, with a cost per acre of $24.95. At 60 per cent efficiency, the equivalent figures are 42,303 acres and annual costs of $16.64 per acre.

If less water were to be pumped, the number of pumps could be reduced. Unless the capital and replacement costs of the pumps declined faster than the volume to be pumped (which is extremely unlikely), the cost per acre would remain the same. It should be noted that these are continuing annual charges, subject to rising real costs of energy and electrical equipment replacement costs.

This is an extremely expensive way of transferring Oldman River water to the south side of the river. The Environment Council therefore concludes that transfer of Oldman River water to the St. Mary Project is not economically feasible.

Irrigation expansion in the St. Mary system is, therefore, practically limited to water supplies that are available by gravity from the Waterton, Belly, and St. Mary Rivers, both in the near and far future. If costs dictate that only gravity fed systems are to be used in the St. Mary system, the acres that can be irrigated with or without an onstream dam are similar.

With Forty Mile Coulee at 70,000 acre feet, with Chin Coulee Reservoir expanded by 140,000 acre feet, with the St. Mary Main Canal rehabilitated and expanded from Sauder to Milk River Ridge Reservoir, with minimum stream flow criteria in the Belly, Waterton, and St. Mary Rivers of 30 cfs, and with no additional private irrigation in the St. Mary system, a total of about 495,000 acres can be served in the St. Mary Project.

For an onstream dam to increase irrigated acreage in the St. Mary Project above about 495,000 acres, proposed offstream facilities and the Chin Pump would be required. With the Chin Pump, minimum stream flow criteria in the Belly, Waterton, and St. Mary Rivers could be increased or irrigated acreage in the St. Mary Project could be enlarged. An onstream dam could increase the acreage irrigated in the LNID or mainstem Oldman River private irrigation, or both. However, without pumping at Chin an onstream dam could not increase irrigated acreage in the St. Mary Project above about 495,000 acres.

7.7 DETAILED CONSIDERATION OF PROPOSED STRUCTURES

Given this broad background of water and land availability south of the Oldman River, detailed consideration of the various facilities proposed in the area can be examined.

7.7.1 Forty Mile Coulee

7.7.1.1 Present Facility

Klohn Leonoff (1978a) describes Forty Mile Coulee as a glacial spillway channel located approximately 65 miles east of Lethbridge and almost directly south of Bow Island. The coulee has a limited surface and groundwater inflow from the surrounding area, although some groundwater springs were noted near the colluvium-bedrock interface along the valley walls. The upper valley slopes are intensely gullied for short distances back from the edge of the valley. However, virtually no slumping was observed along the valley in the vicinity of the proposed east and west dam sites. The SMRID Main Canal crosses the coulee in a wooden stave siphon adjacent to the northwest end of the proposed reservoir.

7.7.1.2 Proposed Changes

The Management Committee endorses a plan to construct a 70,000 acre-foot capacity storage reservoir in the coulee to extend approximately 10 miles southeast of the present siphon at a cost of $36 million. Twenty-five hundred acres of land would be flooded, the majority of which would be contained within the steep-sided coulee walls. Two earth-filled dams are required, one at each end of the proposed facility. The actual dam sites for the Forty Mile Coulee scheme have not been selected. Typical sites were chosen for cost estimates only, but the final selection would require detailed site studies. Based on preliminary information, the most cost-effective dam height is 90 feet at a full supply level of 2,677 feet.

During periods of high irrigation demand, it would be necessary to pump water from the reservoir into the main canal downstream of the siphon. At other times, water could be released by gravity from the main canal into the reservoir through an inlet structure upstream of the siphon crossing. Based on the Water Balance Model prepared for the Phase II studies (Acres 1978), an inlet capacity of 1,000 cfs and a pumping capacity of 700 cfs were chosen. Because of the small local inflow to the proposed reservoir, spillways and low level outlets have not been designed for the project. A new inlet chute would be required from the main canal to the reservoir. Tentative plans call for construction of a 2,500 foot long, 1,000 cfs capacity canal leading from a point upstream of the existing siphon to an inlet chute.

7.7.1.3 Justification for Changes

a. Improved Water Supply

An offstream storage facility is required at the eastern end of the St. Mary system for improvement in operational efficiency through a reduction in the amount of time it takes the water to reach irrigation acres in this area as well as for the storage it supplies.

b. Engineering Feasibility

The proposed full supply level is approximately 100 feet below the surrounding prairie. Klohn Leonoff (1978a) has stated this would have little or no effect on groundwater levels in the area, although reservoir seepage potential has not been evaluated in detail. Preliminary test holes, however, indicate that seepage near the east dam site is a possibility. Deep lacustrine deposits at each site pose design problems of settlement and stability.

7.7.1.4 Impacts of Proposed Changes

Twenty-two individuals presenting briefs at the hearings were in favour of the construction of a reservoir at Forty Mile Coulee (briefs 152, 153, 154, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 168, 171, 172, 173, 175, 176, 181, 184, 188). Improved recreation benefits were cited by some as positive aspects of this facility (briefs 152, 154, 156, 157, 159, 164, 165, 172, 173, 175). More water available for irrigation and domestic and municipal water supplies were other advantages (briefs 152, 157, 158, 159, 160, 161, 162, 163, 165). On the whole, residents in this area believed the socio-economic impacts would be positive, although two landholders in the area indicated their farming operations would be hampered through loss of grazing leases (briefs 166, 238). They would require alternative grazing leases as compensation. The areas of Bow Island and Foremost would likely benefit from the expansion (briefs 154, 161, 168, 176).

7.7.1.5 New Alternatives

Apart from the plan to construct a reservoir at Forty Mile Coulee, an engineering investigation for Alberta Environment has been brought to the attention of the Council regarding the possibility for water storage at Yellow Lake, which is a closed system. Water can flow in, but there is no natural outlet from the basin. Until recently, evaporation accomodated inflow; however, irrigation return flows have recently led to a substantial increase in the level of the lake to the point where water levels are threatening five local roads. It is now necessary to pump water out of Yellow Lake into the Grassy Siphon. Perhaps Yellow Lake might have some desirable characteristics as a recreation facility as apparently there is a significant pike fishery there now.

Approximately the same storage as proposed for Forty Mile Coulee could be stored in the upper part of Yellow Lake, requiring only one dam and hence a savings on capital costs. However, the costs for pumping from Yellow Lake into the main canal would be greater than for the Forty Mile Coulee scheme because the head would be greater. The northern end of the proposed Forty Mile Coulee scheme is approximately 50 feet higher than the southern end of Yellow Lake at that point. If the dams for the two proposed reservoirs were approximately the same height, there would be an additional 50 feet (approximately) of pumping head for the Yellow Lake scheme compared with the Forty Mile Coulee scheme. The spring runoff presently being dumped should be gathered and stored. A scheme for storage in this end of the basin should consider this fact along with the problems associated with raising water levels in Yellow Lake. The Sherburne Lake, Yellow Lake, and Forty Mile Coulee sites offer several alternative proposals. It should be possible to recommend that one site be developed primarily for storage so that fluctuations in water level are of little concern, while another site could be developed for recreation in order for levels to be maintained through supply by the other reservoir.

Engineers advise that what is required now is a good water balance model for this end of the basin. Until the timing and amount of water demands are understood, it is virtually impossible to decide how the system should be designed. The model is also considered necessary before decisions could be made on the significance of pumping costs for Yellow Lake relative to Forty Mile Coulee. It would also assist in decisions related to whether or not it is possible to run a storage reservoir/recreation reservoir pair to any advantage. If it is necessary to pump from Yellow Lake to keep levels acceptable, and if Yellow Lake (or at least the lower part) could be supplied by gravity from Sherburne Lake, Forty Mile Coulee, or Upper Yellow Lake, then perhaps a priority of extension/expansion should be given to the irrigable acreage north of Grassy Siphon. Water must be pumped out of the siphon already; it might as well be pumped and used, as pumped and dumped. Further, having a flow through Lower Yellow Lake would help maintain water quality if it were to be used for recreation.

The Environment Council believes that planning for this area should be done with the following factors in mind: roads (both those being threatened by the rise of Yellow Lake from irrigation returns and those affected by the building of reservoirs), reservoirs for recreation and storage, canals for moving water but also for accommodating the catching and storing of spring runoff, a drainage system, pumping costs and options both for return flows out of Yellow Lake and the irrigation water out of the reservoir(s), and social and environmental impacts. Consideration of pumping costs should include the option of using windmills for pumping return flows, particularly since the timing of the pumping would not be critical. The costs of pumping irrigation water should include consideration of "interruptable power" at off peak rates.

The size of the canal system at Forty Mile Coulee should be reassessed. At present, the proposal is for the canal to be reduced to 1,200 cfs above Forty Mile and then increased to 1,900 cfs below the reservoir. If the 1,200 cfs size causes problems with accommodation of spring runoff or heavy flows during wet periods, essential for the filling of Forty Mile Coulee, the additional cost of enlarging the main canal above the reservoir would be worth the investment.

7.7.1.6 Recommendation

The Environment Council is not in a position to comment on the Yellow Lake alternative as a storage reservoir. It may or may not be superior to Forty Mile Coulee. The Council can only report that the Forty Mile Coulee site was one which brought virtually unanimous support at the Public Hearings and received only two negative responses (briefs 166, 238) which should be relatively easy to rectify. Environmental values, though important, are not unique and their loss is acceptable. There is an urgent need for the facility, and it is difficult to believe that delays for further study of a Yellow Lake alternative will be justified.

7.7.2 Sauder

7.7.2.1 Present Facility

Sauder Reservoir is a small balancing reservoir on the SMRID Main Canal, approximately 10 miles west of Medicine Hat. The present capacity is 4,500 acre feet.

7.7.2.2 Proposed Changes

The Management Committee suggested this facility be enlarged to store an additional 20,500 acre feet for a total storage capacity of 25,000 acre feet. Approximately 2,300 additional acres of land would be flooded in order for a full supply level of 2,605 feet to be achieved at the desired capacity. Final costs and final shape of the reservoir are not known.

7.7.2.3 Justification for Changes

a. Improved Water Supply

Increasing the size of Sauder Reservoir was considered by the Management Committee to be desirable for more effective utilization of the additional water made available by creation of a storage facility at Forty Mile Coulee and enlargement of the SMRID Canal. The Committee suggested enlargement of the present reservoir is required for an overall improvement in operational efficiency of the St. Mary Project, primarily because of its location at the east end of the system. A concern raised at the Hearings was whether or not the proposed expansion of Sauder Reservoir would be necessary if the SMRID Main

Canal were enlarged to the suggested capacities and Forty Mile Coulee Reservoir were developed (brief 165).

Another comment, however, gave Sauder Reservoir priority over the alternative offstream sites in the St. Mary system because of its location further downstream (brief 160). One point in its favour involves the question of time lag. It would take less time to expand Sauder and get it operating than to construct Forty Mile Coulee Reservoir for which a time lag of five to six years has been anticipated.

b. Engineering Feasibility

Underwood McLellan (1977) conducted very preliminary engineering studies for this site prior to the recommendation of the Management Committee and there has been no work at the site since then.

7.7.2.4 Impacts of Proposed Changes

A major concern is the inundation of approximately 2,300 additional acres of irrigated land. Half of this acreage is used by the Winnifred Hutterite Brethren; the remainder involves several farmsteads. Many individuals are concerned that the loss of land would hamper farming operations and result in a loss of farm income (briefs 186, 187, 188, 190, 192, 196, 204). In several cases, the irrigated holdings supplement dryland operations. In addition, a negative social impact would arise from relocation of affected landowners, with attendant severing of family ties and associations with their land and heritage (briefs 186, 187, 188, 190, 196, 204).

Alberta Environment has indicated that with selective diking, both at the location suggested by the Hutterites and along the east/west road to Medicine Hat, the reservoir could be contained to avoid flooding the Hutterite colony homes and livestock buildings and could maintain the existing road. These modifications would require additional drainage works, but they are not considered to be technically difficult. One suggestion was made that instead of flooding additional land, a dredging operation at the present site be implemented as an alternative (brief 189). An additional statement questioned the potential for seepage and salinization of lands adjacent to the suggested reservoir boundaries (brief 204). A final comment presented criticized the level of information upon which the recommendation for this site was based and proposed that further studies be undertaken to ensure that impacts were minimized (briefs 153, 187).

The major attraction of this proposal is operational. It would solve a real problem in helping to provide water to about 30,000 assessed acres lying below the site in an area that is at the end of the system. It is also estimated that it could be constructed and operational in one year while Forty Mile Coulee Reservoir, which might reduce the need for Sauder Reservoir, would take five to six years to become operational.

The permanent flooding of 2,300 acres of land to confer improved reliability on about 30,000 acres of land for a period of four to five years does not seem justifiable. No social impact assessment was undertaken at Sauder Reservoir, but the impression from the Hearings was that it disturbed the greatest number of farms and families per acre foot of storage of any structural proposal, onstream or offstream in the Oldman River Basin.

The tenuous and possibly temporary benefits, the lack of solid engineering investigation, the high level of social and agricultural disruption associated with the site, all suggest to the Environment Council that a decision on Sauder Reservoir should be delayed until more information on precise operational requirements are obtained. This could be either through operational experience after Forty Mile Coulee Reservoir and main canal improvements are completed and operating, or through the development of an operational engineering water balance model. If either approach can establish the operational need for Sauder Reservoir, it should be constructed, following these guidelines:

1. provide the minimum storage necessary to improve the operation of the system;
2. design the reservoir to minimize the loss of irrigated land and the impact on local farms; and
3. prepare the designs in full consultation with local farmers. They have many suggestions for minimizing the impact of the enlarged reservoir that should be fully investigated.

7.7.3 Chin Coulee

7.7.3.1 Present Facility

Chin Coulee is described as a glacial spillway channel located approximately 20 miles south of Taber. A storage reservoir for the SMRID has been created here by the damming of each end of the channel. At a full supply level of 2,829 feet, the storage is approximately 167,000 acre feet; at low water level, elevation 2,782 feet, the storage is reduced to 157,000 acre feet. Water enters from an intake chute near the west end of the reservoir and is released by gravity through an outlet nearby to flow directly into Stafford Reservoir.

7.7.3.2 Proposed Changes

The Management Committee recommends consideration be given to enlarging Chin Coulee Reservoir in the far future. Klohn Leonoff (1978a) assumed an additional 140,000 acre feet of storage and, therefore, carried out a feasibility study for an enlarged facility utilizing the present dam sites and requiring a full capacity level of 2,861 feet at a proposed cost of approximately $32 million. This would be an increase of 32 feet over the present full supply level.

7.7.3.3 Justification for Changes

a. Improved Water Supply

According to the manager of the SMRID, an enlarged Chin Coulee Reservoir is not expected to improve the operational efficiency of the St. Mary Project. In order to shorten the time lag between the release of water from a storage site to the arrival of the water at the farm, several properly distributed smaller reservoirs are superior to one large one.

As the St. Mary Project approaches the full utilization of the mean annual flow of the southern tributaries of the Oldman River, the effectiveness of additional storage declines.

Underwood McLellan (1977) did not propose the enlargement of Chin Coulee Reservoir in their recommendation of facilities necessary in order to expand irrigation acreage to 500,000 acres downstream of the Milk River Ridge Reservoir.

However, information from Acres indicates that expansion by 140,000 acre feet of live storage is required if 490,000 acres in the St. Mary Project are to be irrigated. Chin Coulee Reservoir is somewhat marginal with an additional 30,000 acres irrigated at current levels of efficiency at a capital cost of $32 million, a cost per incremental acre of slightly over $1,000 per acre. However, if the recommendations for improvements in efficiency outlined elsewhere in this report were to be achieved and more acres irrigated with the water saved, the economic prospects for this facility would be substantially improved. The Council, therefore, recommends that if future experience in the St. Mary Project indicates that significant advances towards an overall 60 per cent irrigation efficiency are achieved then expansion of Chin Coulee Reservoir by 140,000 acre feet should proceed.

b. Engineering Feasibility

Only a general assessment of the bedrock and surficial geology is available, and this originates from the literature. Deep lacustrine deposits, therefore, are assumed to underlie Chin Coulee because of its similarity in origin to Forty Mile Coulee. Verbal reports of some foundation failures during construction of the two dams at Chin Coulee, as well as the actual design of the two present structures, reinforce this assumption, leading to a recommendation by the Klohn Leonoff group that staged construction of the two dams would be required to allow for adequate foundation settlement.

7.7.3.4 Impacts of Proposed Changes

No briefs presented pointed to any major adverse socio-economic impact associated with enlargement of the reservoir at Chin Coulee. Two individuals, however, were concerned with the impact on the present recreation resource, after remarking that the present facility has a benefit to recreation (briefs 2, 81).

In summary, since the Environment Council believes that irrigation efficiency improvements in the future will make the expansion of Chin Coulee Reservoir economically attractive, it should be constructed when progress towards improving efficiencies has been established and the demand for increased irrigation acres warrants.

7.7.4 St. Mary Main Canal

Below the Milk River Ridge Reservoir, the St. Mary Main Canal is the responsibility of the St. Mary River Irrigation District. However, the main canal has many of the characteristics of a headworks facility. It is very large. The canal capacities from Milk River Ridge Reservoir to Chin Coulee range from 2,600 cfs to 1,780 cfs. Even the stretch from Forty Mile Coulee to Sauder Reservoir has a capacity of from 840 cfs to 310 cfs. The capacities will become even larger when it is expanded to the size necessary to distribute water to the potential of the system (Underwood McLellan 1977). The proposed canal sizes from Forty Mile Coulee to Sauder Reservoir range from 1,900 cfs to 1,000 cfs.

Construction will be costly. The Management Committee estimates that reconstruction of the whole main canal will cost $40 million in 1978 dollars. Finally, the St. Mary Main Canal is a common carrier. It provides water not only for the St. Mary Irrigation District, but also Raymond and Taber Irrigation Districts. Headworks are normally the responsibility of Alberta Environment. This is presumably based on the size, engineering complexity, and the cost of providing these facilities. In the Lethbridge Northern Irrigation District, the headworks include the main canal and Keho Lake.

On the south side of the river there seems to be an equally valid case for the definition of headworks to include the St. Mary Main Canal from Milk River Ridge Reservoir to Sauder Reservoir, including the reservoirs at Chin, Forty Mile, and Sauder. The operation of these facilities should be left with the districts, as in the case of the LNID, but their design, construction, and maintenance should be the responsibility of Alberta Environment.

There was no opposition at the Hearings to the reconstruction and enlargement of the St. Mary Main Canal, and two briefs (160, 162) specifically supported enlargement. There seems to be little adverse social or environmental impact in connection with the reconstruction of the main canal.

The Management Committee recommended the priority reconstruction of the canal from Chin Coulee to Sauder Reservoir. The Environment Council endorses that recommendation and suggests that work on it commence immediately so that it is complete before Forty Mile Coulee Reservoir is operational.

In summary, the Environment Council recommends the construction of the following facilities on the south side of the Oldman River to permit the maximum economic expansion of irrigation acreage in the St. Mary Project:

1. reconstruction and enlargement of the main canal—Forty Mile Coulee to Sauder Reservoir.
2. construction of about 70,000 acre feet of storage in the vicinity of Forty Mile Coulee.
3. enlargement of Sauder Reservoir to the minimum required for operational purposes if its necessity is established.
4. the reconstruction and enlargement of the main canal from Milk River Ridge Reservoir to Forty Mile Coulee. The design must be consistent with the decision made about enlarging Chin Coulee Reservoir.
5. the expansion of Chin Coulee Reservoir by 140,000 acre feet after it is clear that reasonable progress towards the achievement of efficiency targets has been established.

8. IRRIGATION EXPANSION NORTH OF THE OLDMAN RIVER

8.1 LETHBRIDGE NORTHERN IRRIGATION DISTRICT

Within the basin, only one irrigation district is found north of the Oldman River, the Lethbridge Northern Irrigation District (LNID). In 1977, the LNID had 111,736 acres of land on its assessment roll, with 725 water users. The LNID, because of its east-west extent, lies in a soil/climate transition area. The soils of the whole of the district are classed as Dark Brown, but rainfall during the growing season (April to August) varies substantially. To the west of Fort Macleod, growing season rainfall is 11 to 12 inches, the same as the Foothills Districts. From Fort Macleod to Picture Butte, growing season rainfall is 10 to 11 inches; while east of Picture Butte, it is 9 to 10 inches. In relation to temperature, the line demarcating 120 frost-free days just touches the northern tip of the LNID, with almost the whole district falling within more than 120 frost-free days. The frost-free period in this area is shortened not so much by late spring frosts, which are similar north and south of the Oldman River, but by the arrival of early fall frosts. The line marking earlier fall frosts (September 1 to September 15) just touches the northernmost part of the LNID. (See Figure 1.)

The difference of an inch or two of rainfall during the growing season is critical to the success of dryland farming. In the SMRID (East), where growing season rainfall is below 8 inches per year, Anderson (1978) found dryland farms trading hands at $189 per acre (acreage sold January to June 1977). In the Taber Irrigation District, where the growing season rainfall is between 8 and 9 inches, dryland land values were $220 per acre. In the Lethbridge Northern, where the bulk of the district falls between 9 and 11 inches of growing season rainfall, dryland land values rise to $376 per acre.

The LNID within its east-west extent contains as much contrast as the SMRID. Where the transition in the SMRID is from moderately dry in the west (Coaldale-Lethbridge area) to extremely dry in the east (east of Grassy Lake), the transition in the LNID is from moderately dry in the east (the area east of Picture Butte is identical to the Coaldale-Lethbridge area) to moderately wet in the west. West of Fort Macleod, rainfall in the LNID is the same as in the Foothills Districts. Therefore, the LNID contains land which ranges from excellent to marginal for irrigation agriculture. This is reflected in the overall crop mix. Specialty crops and grain corn represent 9.4 per cent of the crops grown.

The LNID was first developed in the 1920s, so irrigation farming has been practised for over 50 years. The low representation of specialty crops is not the result of an immature irrigation economy, but is instead a recognition of the inherent limitations of climate and soil, and an adjustment to these limitations. Again, though no detailed information is available, the eastern and drier part of the district would likely be most heavily represented in specialty crops, with the western part having a higher proportion of forages.

The surplus generated in the LNID reflects these two tendencies. At $48.81 per acre, it is higher than SMRID (East) but below Taber and SMRID (West). The historical maturity of the district leads to efficient irrigation farming, while climate and soils limit the growth of more profitable specialty crops.

Unlike the St. Mary system, the LNID has a limited amount of land which can be readily irrigated from the existing canals and distribution system. As noted in Section 4.1.1 between 28,500 and 57,000 acres of irrigable land in the LNID are readily available for irrigation in or near the district. Any further increase in acreage beyond about 170,000 acres would mean developing completely new irrigation areas. However, new development in the west of the district is not as economically attractive as other areas due to higher natural precipitation and lower heat units. Developments to the north of the district run into the threat of earlier fall frosts.

Four new development areas available in the LNID are Albion Ridge, Barons, West Barons, and South Keho. Alberta Agriculture (1978a) listed 25 irrigation expansion possibilities in order of priority based on soils, climate, topography, project costs, and relation to market centres. Of these 25 expansion potentials (see Appendix 5), South Keho ranked first of those in the LNID, but it was 14 overall for basin-wide expansion priorities. The 13 expansion projects that outranked South Keho are all associated with the St. Mary Project. The expansion potential in South Keho identified by the Irrigation Division is 12,000 acres. Unlike the south side of the river, the north side comes up against a restriction of suitable acres to irrigate.

Between 28,500 and 57,000 additional acres in the LNID warrant irrigation. They are close to existing water distribution systems, and the cost of supplying additional water is not excessive. When water must be supplied to new areas, the total cost of constructing new delivery systems must be considered. These are considerable, and it becomes a real question whether the anticipated returns from irrigation warrant the cost of new construction. An illustration of such a decision by the farmers themselves took place in the Albion Ridge area in 1978. They turned down a proposal from the LNID to extend water into their area, although the district was offering a subsidy of $250 per acre out of the total cost of $608 per acre. The $358 per acre that the farmers would have had to pay was considered excessive, so they rejected the proposal. None of the other expansion areas in the LNID is likely to cost less than $358 per acre to develop and, since farmers have already rejected that as too expensive, it is unlikely that other projects in other places of equal or greater cost would be found acceptable. Other expansion areas do not seem to be more attractive than Albion Ridge from the point of view of soils, climate, and potential crop returns. Therefore, beyond about 57,000 incremental acres, the Environment Council cannot justify recommending additional acres that are costly to service, are unlikely to be fully productive for the total range of irrigation crops, and are beyond the irrigation farmers' willingness to pay. Anderson (1978, p. A-56) points out that in 1977 the basin average difference in value between dryland and irrigated land was $214 an acre. In the LNID, this difference was $101; in the SMRID (West), it was $384. Therefore, it is not surprising that farmers in the Albion Ridge would reject expansion at an assessment of $358 per acre.

It should be noted that, based on the rate of growth of assessed acreage between 1969 and 1977, by 1990 the LNID would have expanded to 156,000 acres while by 1995 it would reach 173,000 assessed acres (Appendix 6); both figures are within the amount that could be served safely by offstream facilities at current efficiencies. There was a moratorium on irrigation water rights in the LNID from 1974. Although irrigated acres with water rights expanded only slightly in this period, from 90,448 acres in 1974 to 91,520 in 1977, terminable acres were increased from 13,886 in 1974 to 20,216 acres in 1977. Terminable acres are provided with irrigation water, but the agreement to provide the water or to accept it can be terminated with appropriate notice as defined in the Irrigation Act by either the board of an irrigation district or the landowner. The moratorium may have slowed, but did not halt, development of irrigation in the LNID. It would be expected that those acres closest to existing irrigation works, which would be relatively inexpensive to water, would be added quickly to the rolls (the intensification acres), but that extension and expansion acres would be added more slowly. The general conclusion is that the 180,000 acres provided for by the Management Committee for the near future in the LNID should be more than sufficient to provide for foreseeable additional irrigation acreage in the LNID.

8.2 KEHO LAKE

8.2.1 Present Facility

Klohn Leonoff (1978a) describes the present facility as a 45,000 acre-foot capacity storage reservoir supplied with water from the Oldman River by the 800 cfs capacity LNID Main Canal. There is no pump; filling of the reservoir is accomplished through gravity. The lake is a natural depression, and at the present full supply level (FSL) of 3,157.5 feet floods approximately 4,600 acres. High ground surrounding most of the perimeter and low road dikes on the east and northeast shore prevent flooding of additional acres. Present lake fluctuations range between 3,144.0 feet and 3,157.5 feet. The limiting factor for a higher full supply level under present operating conditions is the level at which water enters the lake from the main canal. Two siphons, one at Rocky Coulee and the other at Keenex Coulee, which are presently being replaced, together account for a drop of 6.75 feet. An additional loss of 15.25 feet occurs on the canal slope to Keho Lake.

8.2.2 Proposed Changes

The plan endorsed by the Management Committee is to raise the full supply level of Keho Lake to 3,163.5 feet, an increment of six feet, to create a 75,000 acre-foot capacity storage reservoir at a cost of $6 million. An additional 1,030 acres would be flooded, increasing the total surface area of the facility to approximately 5,630 acres. Modifications to the LNID Main Canal would be required to compensate for backwater effects in the canal resulting from an increased full supply level in the reservoir. Either the existing dikes could be raised, or the canal relocated south to higher ground. The former presents fewer engineering difficulties according to Klohn Leonoff (1978a). In either case, the work could be done in conjunction with a proposed enlargement of the canal to a capacity of 1,500 cfs. In addition, the Rocky and Keenex Coulee siphons are being replaced by canals for recovery of approximately 6 feet of head presently lost in the siphons. If the existing dikes were raised, a further modification would be the construction of a drop structure upstream of Rocky Coulee to dissipate this additional head.

The Turin headworks at the eastern end of Keho Lake would require either modifications or replacement because of the anticipated increase in structural stress. Dikes for the Turin Branch Canal, which would require replacement, could follow the shorter alignment route on higher ground, as recommended by Klohn Leonoff (1978a).

8.2.3 Justifications for Changes

Improved Water Supply

Of the 70,000 acres used in the Water Balance Model as additional near future irrigable acres within the LNID, only 42,000 of these acres are actually within the district, according to the manager of the LNID. Acreage above and beyond this figure represents expansion acres requiring extension of the canal system. Some of these acres are as far as five miles from the existing works and will be very expensive to irrigate. However, an estimated 5,000 acres presently outside the LNID lie within one-half mile of existing works; these would be no more costly to irrigate than the extension acres currently within the LNID. The total of cost-effective irrigable acres within and bordering the LNID, therefore, is approximately 47,000 acres. Keho Lake seems to be a critical facility to irrigate at least half these incremental acres.

8.2.3.1 Engineering Feasibility

Potential seepage was a concern raised by numerous individuals at the hearings (briefs 3, 8, 18, 21, 39, 47, 58, 59, 66). Klohn Leonoff (1978a) states that seepage from the present lake is minimal, however, and does not anticipate significant problems if the reservoir is enlarged. One individual referred to the existence of surface bedrock at the site of the Keho Lake expansion and pointed out the potential for drainage problems. Klohn Leonoff (1978a) did not detect surface bedrock in its engineering studies, but, in 1977, Alberta Environment encountered bedrock in shallow holes drilled along the proposed dike lines. Perhaps leakage from the bottom of the dikes is a possibility. The Environment Council, however, assumes that detailed engineering design and construction would overcome these problems.

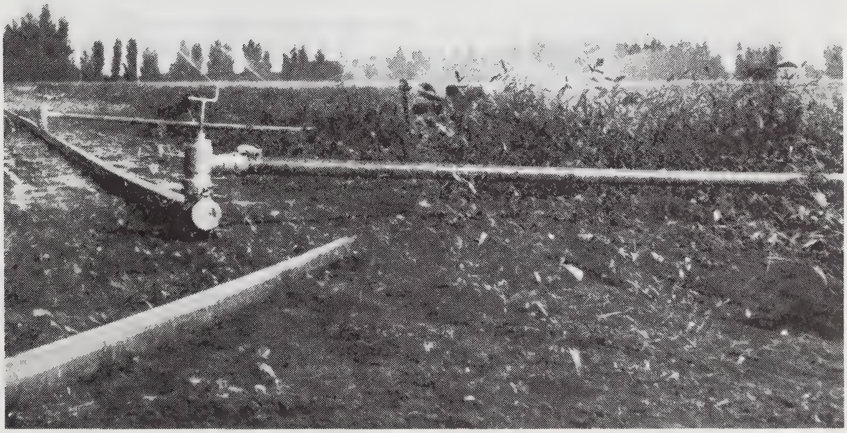
There was further concern along these lines with regard to the Village of Barons (briefs 59, 66). If the level of Keho Lake is raised and the canals are enlarged, what would be the effects on the village, parts of which are below the level of the present lake? Alberta Environment has stated that, in 1969, the Soils Branch, Earth Sciences Division, investigated the seepage problems away from Keho Lake towards Barons and on adjacent farmland. There was seepage, but their studies concluded that the problems experienced at the village, and between the village and the lake, were caused by dryland seepage water which discharged from groundwater, well above the full supply level of the lake. Further studies showed that there is no connecting underground layer between the lake and the village. On the contrary, both a topographic and bedrock high exist between the two, acting as a groundwater divide, thereby placing Barons and the lake in different surface drainage basins.

8.2.4 Impacts of Proposed Changes

If Keho Lake were enlarged, some farmsteads would require relocation. Of those residents who would not necessarily require relocation, economic hardship could result from farming operations being hampered by land losses and division of land (briefs 3, 8, 18, 42). Three briefs (39, 42, 47) indicated more opposition than reports suggest, implying that more residents of the area affected by the proposed development would have voiced their opposition had they been asked directly.

The potential for drainage problems and additional seepage was discussed above. Further problems arise from drawing down water levels in a shallow basin. Exposed mudflats at the present site are unsightly and detract from the recreation potential of the lake. Winds in this region create dust storms and erosion at the present site. More extensive mudflats, which would occur with the proposed expansion, could result in more dust, more erosion, and even less potential for recreation than currently exists (briefs 3, 39, 42, 47, 59).

There is concern that the proposal will cover an excessive amount of good farmland (briefs 47, 58, 59), more so than is indicated on the outline map (brief 18). Also, a large surface area of water will result in excessive evaporation losses (brief 58). Briefs 30, 65, and 226 mentioned that the water above the outlet of Keho Lake is not being used to full capacity, which raises the question: If the levels were raised to full capacity, would the proposed expansion be necessary?



Alberta Photographic Services

A hand-move sprinkler system.

The people of Barons are also concerned that if Keho Lake were enlarged and the canal from Keho relocated, the water intake for their town water supply would require relocation (brief 66). They are concerned about the cost of this work and who will pay for it. The expansion of Keho Reservoir will substantially affect Keho Park and golf course. (See Section 3.3)

Canadian Hunter Exploration Limited has stated that one oil well, known as Canhunter Keho 11-24-11-23-W4M, will be under four feet of water if the Keho Lake proposal is undertaken (brief 211). Operation of the well under this shallow water cover should not be technically difficult.

At this stage, the engineering feasibility appears to be sound, although intensive field studies are required before actual construction could begin. The socio-economic impact promises to be severe, however, and much needs to be done to minimize the impact to landholders who would be affected. The use of freeboard dikes to mitigate damage to affected landholders should be fully investigated. Keho Park will need relocation and the golf course will require compensatory land adjacent to the present course. Both recreation areas must be reconstructed to at least the standard of the present facilities.

To summarize, then, the enlargement of Keho Lake is a cost-effective approach for supplying water to support irrigation on the additional intensification and extension acres within and adjacent to the LNID. It does not make sense, however, to expand the reservoir without prior reconstruction of the LNID Main Canal to a capacity of 1,500 cfs. Therefore, the Environment Council recommends construction of the expanded reservoir to be phased with main canal reconstruction so that both are completed concurrently.

8.3 ROCKY KEENEX

8.3.1 Present Facility

Rocky and Keenex Coulees are two natural depressions located approximately 10 miles west of Keho Lake. Each is crossed by siphons, although the one at Rocky Coulee is being replaced by an earth embankment as the first of the major projects in the reconstruction of the LNID Main Canal.

8.3.2 Proposed Changes

Klohn Leonoff (1978a) investigated four storage schemes varying in capacity from 45,000 acre feet to 247,000 acre feet. Two of these would require a pumped outflow; the remaining two would function with a gravity outflow. The proposed earth fills in all cases would be replaced with dikes north of the reservoir. None of these schemes, however, is retained by the Management Committee in the final report. The present construction of the earth embankment at Rocky Coulee as a replacement for the siphon, in fact, negates the choice of an offstream storage site at Rocky-Keenex. It is mentioned here only because this site was referred to at the Hearings with several reasons cited in opposition, and none in its favour.

8.3.3 Reasons for Opposition

Three reasons presented in opposition to this facility dealt with either environmental or socio-economic impacts (brief 94). First, loss of land would hamper farming operations resulting in loss in income for those affected. Second, potential seepage problems would affect farm incomes through loss of good farming land to salinity. Third, the social impact could be very significant to the Village of Nobleford and to the area west of it.

In view of the opposition to this site and the fact that the siphon at Rocky Coulee is presently being replaced, the Environment Council supports the recommendations of the Management Committee not to consider the creation of a storage reservoir here.

8.4 MUD LAKE

8.4.1 Present Facility

Mud Lake, as the name might suggest, is a shallow body of water northwest of Fort Macleod contained within a natural depression approximately two miles long by one-and-one-half miles wide, with a maximum depth of less than three feet. Present water level fluctuations vary around an elevation of 3,167 feet. The LNID Main Canal, with an annual supply level flucuations ranging between 3,207 and 3,196 feet, is located west and north of the lake.

8.4.2 Proposed Changes

The Management Committee endorses a plan to develop Mud Lake to a capacity of 65,000 acre feet at a cost of $24 million. The reservoir would extend the existing lake boundaries by an additional 3,000 acres to cover a total area of 3,800 acres. Water levels would fluctuate from a minimum of 3,165 feet to a full supply level of 3,193 feet. At the minimum supply level, most if not all of the new acres inundated at the full supply level (FSL) would be exposed by drawdown.

During high flow periods, the reservoir would be gravity filled through an 800 cfs capacity chute inlet from the LNID Main Canal; during peak demand, a 700 cfs capacity pump would move the water from the lake back into the main canal. The reservoir could be contained by dikes on the north, east, and south sides, and by high ground to the west. A 200 cfs capacity outlet structure through the dike on the east side of the proposed reservoir would release stored water as required to Willow Creek for emergency maintenance of Oldman River flows.

8.4.3 Multiple Use

In the sequence of requirements for expansion of irrigation in the LNID, rehabilitation and enlargement of the main canal would rank first, the enlargement of Keho Reservoir second, and construction of Mud Lake Reservoir third. Operationally, Mud Lake is distant from the main demand for irrigation water. However, as proposed, it is a very flexible facility.

8.4.3.1 Irrigation

Mud Lake will assist in providing water for irrigation of the 57,000 acres estimated to be added to the LNID in the future.

8.4.3.2 Level Stabilization

To fill Mud Lake in the spring at 800 cfs will require approximately 40 days, during the spring freshet. Once filled, and without further drawing on the river, it could be used for approximately 47 days to provide 700 cfs to the main canal and Keho Lake. If, for recreation purposes, the fluctuations on Keho Lake are to be minimized, Mud Lake could be operated so that lake level fluctuations were concentrated there, while the level of Keho Lake was maintained.

8.4.3.3 Stream Flow

If stream flow levels in the Oldman River were of concern, water stored in Mud Lake could be released to the Oldman River through Willow Creek at 200 cfs. This could be a substantial contribution to maintaining minimum flows at 360 cfs, measured at Lethbridge. Mud Lake would take 164 days to empty if used for streamflow maintenance alone.

8.4.3.4 Storage

If Mud Lake were to be used for both spilling water for streamflow maintenance (200 cfs) and pumping into the main canal (700 cfs) at full capacity, it contains sufficient water to operate for 36 days without drawing on the Oldman River for recharge.

8.4.3.5 Offstream *versus* Onstream Storage

One point raised at the Public Hearings was that storage of water onstream was somehow superior to the storage of water offstream (briefs 21, 47, 167, 220). The concept was expressed as the "waste" of water from the spring runoff flowing to Hudson Bay. An onstream dam was seen as the best way to capture this excess flow for later use during the dry season. It is certainly one way to do so, but it is not necessarily a superior way. The important thing is that water required during the dry season is taken during spring thaw and stored. It is immaterial whether it is stored onstream or offstream, and it is not economic to remove and store more water than needed. In fact, since water is required in Saskatchewan and Manitoba, it is not wasted. Half of the natural flow of the South Saskatchewan River system must, by federal and provincial agreement, be passed downstream to Saskatchewan.

The LNID diversion and canal could, if enlarged, take 1,500 cfs from the spring run off to Mud and Keho Lakes, which together store 140,000 acre feet. The need to tap the Oldman River for additional water during periods of low flow would be eliminated in most years and very much reduced in dry years. The Water Balance Model (run 106-1) assures us that 180,000 acres of irrigated land could be served by Keho and Mud Lakes and an enlarged main canal at current efficiencies, with only a 10 per cent shortage once in 12 years, well within the failure criteria adopted by the Management Committee. As noted above, 180,000 acres is not an interim figure for irrigation acreage in the LNID, but a maximum figure, which is not likely to be exceeded.

8.4.4 Engineering Feasibility

Klohn Leonoff (1978a) stated in their Phase II report that potential seepage from the reservoir is of major concern. They do not anticipate serious water losses though, because they detected that in each drill hole where the impervious till layer was missing, the gravels were covered with thick beds of lacustrine silt and clays which would effectively prevent such water losses. If the lacustrine beds prove to be discontinuous, an impervious layer of appropriate materials could be mechanically laid over the area. If sand strata occur in the valley at the bottom of the lake as has been suggested, Alberta Environment believes these could be effectively sealed. Horizontal movement of water through the dikes is a possibility; therefore, a dike design was suggested by Klohn Leonoff to minimize this problem.

8.4.5 Impacts of Proposed Changes

The primary environmental concern expressed at the Hearings was the potential for additional salinity problems (brief 41). Salinity on lands close to the present lake is a problem and, with the less-than-ideal geological foundations underlying the proposed facility, additional seepage is possible.

A second point involves the question of drawdown. At the minimum supply level of 3,165 feet, approximately 3,000 acres of newly flooded land would be exposed. This would greatly diminish any aesthetic appeal for the area and would diminish its attraction as a potential recreation resource.

The social impact appears to be less than for Keho Lake, with fewer people being disrupted resulting in a minimal impact on the local community. Some farming operations would be hampered, and one ranch in particular would require compensatory grazing land in order to remain a viable unit (brief 49).

In summary, then, there are four functions associated with the operation of a storage facility at Mud Lake. It could act as a balancing reservoir to benefit the LNID in dry years and to increase the value of Keho Lake as a recreation resource by minimizing lake fluctuations there. It could also assist in maintaining downstream flows in the Oldman River during critical periods and could supply water for increased irrigation in the LNID. On the negative side, the costs associated with construction of this facility are high, with capital costs estimated at $24.0 million and pumping costs at $0.66 per acre foot.

Social and environmental costs are minimal at this location, and the flexibility and potential multiple uses to which the facility can be put warrants its ultimate construction which should begin after the main canal reconstruction and enlargement is completed, after the expansion of Keho Reservoir is completed, and after about 30,000 incremental acres have been added to the assessment rolls of the LNID. The Environment Council estimates that this would occur about 1985.

9. ONSTREAM STORAGE

9.1 INTRODUCTION

Three onstream storage sites were considered by the Management Committee: Three Rivers, Brocket, and Fort Macleod. The Management Committee rejected the Fort Macleod site and recommended construction of a dam at either Brocket or Three Rivers in the far future. The Environment Council does not believe that an onstream dam is required to provide for the development of irrigation to its maximum economic potential in the basin. Although the Environment Council does not recommend construction of any of the onstream dams, the record of the Public Hearings would be incomplete without a report on the representations made at the Hearings with respect to the onstream sites and an assessment of these facilities.

9.2 THREE RIVERS

The Three Rivers site would create 398,000 acre feet of live storage at an estimated cost of $114.4 million (1977 dollars). Its construction would involve flooding 5,800 acres with accompanying extensive social and environmental damage, the largest and most intense of all the onstream sites: 28 homes and 200 other buildings would be flooded completely; 20 viable farming enterprises would be completely wiped out; 14 farming operations would be seriously affected through the loss of farm buildings, gardens, or watering places; and a further six farming operations would be directly affected but in minor ways (Boothroyd 1978). In addition to the direct loss to many long-established farms and farm families (26 of those families totally or seriously disrupted have been residing in the Pincher Creek area for over 40 years), there would be substantial indirect effects on many others. As identified in several briefs, the disruption of the road system would create long detours for many living to the north of the proposed reservoir (83, 115, 118, 122, 123, 131, 132, 141, 142, 149, 151).

From an environmental point of view, the loss would also be substantial, the greatest of any of the onstream sites. The Three Rivers site is a sheltered corridor in the transition zone between the plains and the mountains. The well-watered valley floor provides a vivid, contrast to the grasslands above. It, therefore, provides a wide range of habitats and is an important transition zone for the animals of the mountains and the plains, the grasslands and the forests.

For fisheries, the Three Rivers site is entirely within the cold water zone which has the most desirable range of sport fish, such as trout and mountain whitefish. Because of its favourable environment, it is attractive to hunters, fishermen, canoeists, and general recreationists. Its major deficiency is adequate access. Although the municipal district provides a small campsite on the Castle River, it would be flooded if the dam were built.

For all the above reasons, opposition to the Three Rivers site was voiced frequently and with purposeful intensity at the Hearings. Fifty-five briefs opposed the site (2, 11, 39, 42, 44, 49, 57, 83, 84, 88, 89, 95, 98, 101, 104, 108, 109, 110, 113, 114, 115, 117, 118, 119, 120, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 137, 139, 140, 141, 142, 143, 145, 149, 150, 151, 195, 208, 213, 222, 223, 225). Nine speakers supported a dam at this location (briefs 17, 21, 43, 53, 66, 132, 153, 189, 207). Of those in support, one suggested that land at the Three Rivers site was not valuable (brief 66). Two individuals (briefs 21, 153) contended that the Three Rivers site was more economic than the Brocket site, and four people (briefs 53, 132, 189, 207) said that it would provide either more irrigation farming, improved water quality or recreation, or flood control and hydro generation benefits.

9.3 BROCKET

The Brocket site would create 340,000 acre feet of live storage, flood 4,700 acres, at an estimated cost of $111.7 million (1977 dollars) (Management Committee p. 69). The obvious social and environmental impacts are less severe at Brocket than at Three Rivers. Relatively little agricultural land is developed at the site. It is estimated that 14 homes would be lost, 10 of which would be on the Peigan Reserve. Only three farming operations would be totally disrupted, while nine would be seriously affected. The greatest social disruption at this site would occur on the Peigan Reserve. One brief (218) from the Peigan people pointed out the importance of the river to the Band's way of life.

There are major environmental values at the site. Most of the points made with regard to the Three Rivers site could also be made about the Brocket site, but with less intensity. It is a transition zone, but because it is farther into the plains, it is a less important one. Brocket does provide a contrast between the high prairies and the well-watered river flats, but the valley is more open, and the shelter from the wind is not as great.

With regard to the fishery, Brocket is completely within the cold water fishery zone. As with Three Rivers, construction of a dam would have an impact, particularly on the mountain white fish found there, although water releases might be of some benefit to warm water species below the dam.

Five briefs (2, 23, 153, 184, 207) supported a dam at this location by pointing to the perceived lower social and environmental costs.

Three briefs (84, 88, 218) opposed the damsite. More critically, spokesmen for the Peigan Band, although not completely ruling out the site, stated that it would take the Band at least five years to decide whether it supported or opposed construction of the dam (brief 91). Indian reserve land is unique in that it cannot be expropriated. The collective owners of the land, the Peigan Band, would have to be in full agreement with the release of the land, the construction of the dam, and the flooding of reserve land before development could begin. The Band must be fully convinced that the benefit of the site to themselves, whether through the benefits that the dam and reservoir could convey directly for irrigation and recreation purposes, and the compensation either in money, land or other indirect benefits, fully compensates for their losses. They must be willing rather than unwilling sellers. If the Brocket Dam is to be built, it will only be with the full consent of the Peigan Band.

9.4 FORT MACLEOD

The Environment Council had available a late study prepared for the Management Committee in November 1978, by Klohn Leonoff (1978b). They conducted a pre-feasibility study of raising the full supply level of the reservoir from 3,057 feet to 3,070 feet, which would increase the live storage capacity from 245,000 acre feet to 330,000 acre feet. The consultant estimates the cost of this dam at $95 million (1977 dollars). This estimate includes the cost of freeboard dikes to protect the eastern end of the Town of Fort Macleod.

Pumps would be required to transfer water from this reservoir to the LNID Main Canal. The capital cost of the pumps is $7.5 million, while unit costs for pumping would be $4.35 per acre foot. The reservoir would flood an estimated 5,650 acres at 3,057 feet full supply level. The increased storage does not appear to flood substantially more land, largely because of the use of freeboard dikes.

The Management Committee rejected the Fort Macleod site for several reasons:

1. least storage capacity.
2. high unit cost per acre foot of live storage and high annual operating costs for pumping to the LNID.
3. the large amount of agricultural land taken out of production per acre foot of storage.
4. because of its location downstream of Fort Macleod, the reservoir would receive the town's sewage discharge, would provide no flood or erosion control for the town, and would pose a dust problem at low water.
5. the potential social and environmental impacts are all negative.

Many of the Management Committee's objections to the dam site are overcome with the larger design. The increased storage capacity is comparable to the Brocket site and the capital cost of storage per acre foot is $288 per acre, identical with the Three Rivers site. An objection to sewage discharge is not valid since sewage should be properly treated whether discharged to a reservoir or an undammed river. Some objections remain. Pumping would be required to transfer water to the LNID. There are negative social and environmental impacts, but these are common to all three sites.

The social impact is more serious than at Brocket, but much less than at Three Rivers. Twenty-four Macleod area landholders would be affected by the dam. Four farm homes and yards would be flooded as well as a summer recreation home. Thirteen landowners would find their farm operations seriously affected while 5 would suffer minor disruption. The comparable figures in Three Rivers are 28 homes and 20 farming operations totally lost, 14 farm operations seriously disrupted, while 6 would experience minor disruption.

Seventeen briefs opposed the Fort Macleod site (24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 72, 86, 92, 207, 217) and most of them pointed out serious negative environmental effects. No doubt, locally, the land at the Fort Macleod Reservoir site is attractive, largely for the contrast between well-watered bottom land and open prairie. However, it is not in a terrestrial transition zone, nor does it have important corridor features. It is undoubtedly unique and special to those who live there, but fewer would be disrupted by a dam at this location, than at Three Rivers.

The Fort Macleod Dam site is in an aquatic transition zone between warm and cold water fish species. Pike and mountain whitefish are the most common sport fish, trout being rare this far downstream. Although this site has the least impact on fish resources, a total blockage of mountain whitefish migrations could be expected (they are found downstream nearly as far as Lethbridge). As with all the dam sites, the costs of a fish ladder at this site are likely prohibitive, but engineering estimates would be required before that judgement could be made. If a reservoir were built at Fort Macleod and operated to augment downstream flows, it is possible to argue that it might benefit warm water fish species and water recreationists.

Compared to other onstream sites, the Fort Macleod site would cause somewhat less environmental disturbance than the Brocket site; its social disruption would be somewhat more. Compared to the Three Rivers site, the environmental and social disruption of the Fort Macleod site would be less. In terms of farms totally disrupted, its impact is significantly lower.

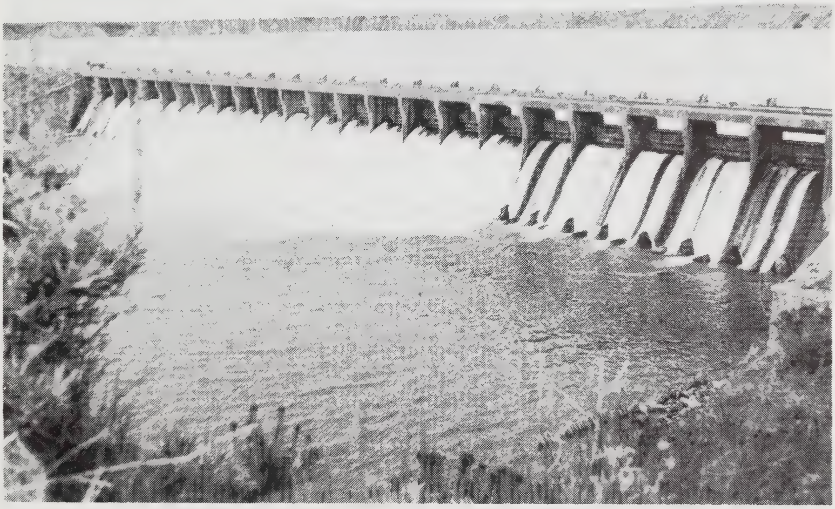
The 17 briefs opposing the site pointed out the loss of wildlife habitat, natural beauty, productive farming land, and the potential mudflats, dust erosion, and seepage. In addition to the loss of farm homes, they also pointed to the loss of the Girl Guide Camp and the first site of the Northwest Mounted Police Post. They also felt that the reservoir would have poor or negative recreational potential in contrast to the high present recreation value. The use of the Oldman River for swimming was mentioned, though as discussed under water quality, the advisability of swimming so short a distance downstream of a sewage treatment plant is doubtful.

These concerns are valid and real, but they are not sufficient by themselves to eliminate the Fort Macleod site from consideration. The major deficiency of the site is its inability to provide water to the LNID by gravity feed and the necessity to pump water to serve that district at a relatively high energy cost. However, even that penalty should be viewed in perspective. A reservoir at Fort Macleod (including the capital cost of the pump) is estimated at $102.5 million. This is $9 million less than the cost of construction at Brocket and $12 million less than at Three Rivers. It should be noted that since these are preliminary estimates, the comparison can only be taken as a rough approximation. However, with these qualifications, if these savings were invested in long-term Government of Canada bonds, an income of between $0.9 million and $1.2 million would be generated. At $4.35 per acre foot unit costs, this would permit the pumping of between 207,000 and 276,000 acre feet of water to the LNID. This would not fully satisfy the future water requirements of the LNID, but can be seen as making Fort Macleod more comparable in overall cost to the sites at Brocket and Three Rivers.

However, an onstream site is not required. The offstream facilities at Keho Lake, Mud Lake, and the enlarged main canal are sufficient to irrigate all the land in the LNID that can be reasonably brought under irrigation, at less than a third of the cost of any onstream facility. An onstream dam is not an effective way of providing water where it is most required, to the St. Mary Project.

As is discussed more fully in Section 7, about 495,000 acres in the St. Mary Project could be irrigated with Chin Coulee Reservoir expanded by 140,000 acres feet, with a minimum monthly criteria in the Waterton, Belly, and St. Mary Rivers of 30 cfs, without an onstream dam. In addition to the 495,000 acres irrigated in the St. Mary Project, an onstream dam could increase irrigation acreage in the LNID above 170,000 acres and provide for the expansion of private irrigation to a total of 138,000 acres. However, an onstream dam could only increase irrigated acreage in the St. Mary Project above 495,000 acres by use of the Chin Pump and the reduction of private irrigation by the amount of water removed from the Oldman River by pumping.

An onstream dam could increase stream flows on the Belly, Waterton, and St. Mary Rivers, to a total of 210 cfs, but again, if irrigation acreage in the St. Mary Project is to be maintained, only by increased pumping at Chin. The view of the Environment Council is that minimum stream flow criteria in the Belly, Waterton, and St. Mary Rivers above 30 cfs is not warranted by the improvement to the fishery that would result, since the modest improvement to this fishery would be at a substantial loss to the fisheries in the Oldman River through onstream dam construction.



Alberta Photographic Services

Large reservoirs store surplus water for release as needed.

The Council has identified elsewhere that it does not feel that expansion in the LNID beyond 170,000 acres is economically justified, and it is doubtful about future expansion of private irrigation, given the realities of increasing energy costs. The Chin Pump is a costly method of transferring water to the St. Mary Project and its development is not recommended. An onstream dam is, therefore, capable of increasing acreage, but not where it is most required, in the St. Mary Project, except by pumping at Chin. The construction of an onstream dam is, therefore, not warranted.

There is, however, one caveat. Irrigation in the LNID depends on the weir at Brocket. The ownership of 4.13 acres on which the weir is built is disputed. The Peigans and the provincial government are currently negotiating access across Reserve land to the weir. If a satisfactory solution to these two land negotiations cannot be achieved, the provincial government seems to have no alternative but to go ahead with the construction of an onstream dam at Fort Macleod. This decision would eliminate the need for Mud Lake, the main canal would only need to be rehabilitated to 1,000 cfs east of the pump outfall, and it might be possible to reduce the storage capacity of the dam substantially. The alternatives become the abandonment of irrigation in the LNID or construction of a Fort Macleod Dam. Although it is hoped that such an eventuality does not occur, under these circumstances the choice is clear.

In summary, at current efficiencies, the overall basin irrigation acreage recommended by the Environment Council is outlined in the following table:

District	Future Irrigated Acreage
LNID	170,000 acres
St. Mary Project	495,000 acres*
Foothills Districts	47,000 acres
Private	74,000 acres
Total	786,000 acres

This amount can be achieved with minimum flow criteria of 30 cfs in the Waterton, Belly, and St. Mary Rivers and with flows on the Oldman River of 360 cfs measured at Lethbridge.

An onstream dam would enable the following targets to be met:

District	Future Irrigated Acreage
LNID	170,000 acres
St. Mary Project	495,000 acres*
Foothills Districts	47,000 acres
Private (residual)	138,000 acres
Total	850,000 acres

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* These figures assume an expanded Chin Coulee Reservoir will add 30,000 acres.

This difference between the two approaches is some 64,000 additional acres irrigated, but the incremental acreage could only be provided to private irrigation (or the LNID) where it is least required.

10. BENEFIT/COST ANALYSIS

10.1 BENEFIT/COST ANALYSIS

Anderson (1978) indicates that the benefit/cost analysis of all the scenarios proposed by the Management Committee show a benefit/cost ratio greater than one. The technical quality of Anderson's work was not directly challenged at the Hearings, and it was frequently pointed out that he very carefully laid out all his assumptions and that if you did not like or did not feel his assumptions were well founded, you could substitute your own. Some points were attacked: the lack of market forecasts (see Section 5), the choice of technical benefit/cost ratios, and the discount rate chosen (briefs 4, 56, 82, 184).

The choice of benefit/cost ratio is a complicated technical problem. The concept behind benefit/cost analysis is simple. The analyst identifies all costs associated with a project, and all benefits flowing from the project, brings them to a common base by using a discount rate (to allow for the different times when costs are incurred and benefits received), and compares them. The arguments heard at the Public Hearing had to do with what were the appropriate benefits and costs to be considered; those that accrued only to the prime beneficiary, the irrigation farmer, or those received as well by townspeople, agricultural processors, and suppliers. The basic argument advanced was that any investment in goods production would generate similar secondary benefits, that the production of motor cars or airplanes would be as beneficial to Lethbridge, as irrigation farming. While that may be true, Lethbridge and other communities in the Oldman River Basin have a set of skills and investments in infrastructure that would enable them to respond well to investments that increased irrigation farming. They have no demonstrated advantage as a home for General Motors or Canadair.

Citing unemployment statistics for the province and Canada, Anderson also argues that there are unemployed resources in southern Alberta, and since there is demonstrated unused capacity, that secondary regional benefits should be included. However, at present, southern Alberta probably comes as close to the current economic criteria of fully employed labour and capital as one can find in Canada. Certainly there is some unemployment, but irrigation farmers at the Public Hearings identified one of their major problems as the unavailability of workers, even for relatively unskilled jobs.

One possible danger in southern Alberta is overheating the economy and creating demands for labour that exert inflationary pressures. Agriculture and agricultural processing industries are not high wage industries either in Alberta or elsewhere in North America. This is normally compensated in large part by the fact that living costs in smaller towns and rural areas are also lower, such things as housing costs and property taxes are usually low, so that the relative net returns are comparable. When large-scale expansion occurs, this delicate balance can be upset. If housing and other costs rise dramatically, there will be pressure on wage levels in agriculture-related industries.

Since most competing agricultural centres would remain untouched by rapid growth, there is the possibility that southern Alberta would lose its comparative advantage in food production. This scenario is not sketched to indicate that all expansion is bad, only to indicate that over-rapid expansion carries dangers. There is a limit to the growth that an area like southern Alberta can handle at any one time. Large building projects, to the extent possible, should be carefully timed and scaled so that their undesirable impacts are moderated.

There is, therefore, some doubt whether Anderson's preferred ratio, including both direct and indirect benefits is appropriate. However, his direct benefit: direct cost ratio is still greater than one, though in the case of onstream dams in the far future, just barely so (1.1:1).

One technical point should be noted. Anderson uses an apportionment criteria with the Bow and Red Deer Rivers at the 1985 level of water use. This assumes that far greater quantities of water from the Red Deer River are available to meet apportionment than the criteria finally chosen by the Management Committee of 75 per cent from the Red Deer River and 50 per cent from the Bow River. This makes little practical difference to calculations for the near future. However, when it is applied to the far future, as Anderson does, it assumes that substantially more water and, hence, more irrigable acres are available than would be the case with a 75/50 (Red Deer/Bow) assumption. Anderson's irrigated acreages for the far future are, therefore, too high by the following amounts:

Fort Macleod	15,000 acres
Brocket	25,500 acres
Three Rivers	42,500 acres.

By assuming the additional acreage can be irrigated, far future benefits are increased while costs remain the same and far future benefit/cost ratios should, therefore, be reduced.

10.1.1 Discount Rates

Anderson uses a 5 per cent discount rate. His argument for doing so is that the real rates of return from farming are less than 5 per cent. Of course, that is the general rate of return from all types of farming and it might have been more appropriate to use a rate of return from irrigation farming which, as was noted previously, is higher than for normal dryland farming.

It is unusual for irrigation works to enjoy a discount rate so much below prevailing market rates. The Water Resources Council under the direction of the President of the United States used the following guideline for evaluating all U.S. irrigation projects.

> The interest rate to be used in plan formulation and evaluation for discounting future benefits and costs . . . shall be based upon the estimated average cost of Federal borrowing as determined by the Secretary of the Treasury taking into consideration the average yield during the twelve months preceding his determination on interest-bearing marketable securities of the United States with remaining periods to maturity comparable to a 50-year period of investment (p. 86).

If comparable criteria were used in Canada, an appropriate discount rate would be approximately 10 per cent. Even if the rate of return on the Heritage Savings Trust Fund were used as the discount rate, it would be close to 9 per cent. As Anderson (1978) notes, "Generally, the higher the discount rate, the less attractive the project will appear to be" (p. 93). Using the total regional net benefits (which includes indirect as well as direct benefits), a discount rate of 10 per cent would reduce the benefit/cost ratio of the Three Rivers site in the far future from 2.17:1 down to 1.29:1. The reduction in acreage due to the use of 50 per cent Bow River and 75 per cent Red Deer River levels for apportionment rather than the 1985 levels would be about 13.1 per cent. Anderson's estimate of the elasticity of this factor is +0.87. This would bring the benefit/cost ratio down to 1.14:1, which is greater than one, though only marginally so. The result of applying these two factors to the 1.1:1 ratio that relates to the direct regional gross benefits indicates that the resultant ratio would be down to 0.60:1, substantially below unity.

10.1.2 Cost Effectiveness

One thing the benefit/cost analysis does not do is identify the cost effectiveness of individual components proposed for water management. It is common practice, and sound economics, first to add the lowest cost increments to any production facility. At the point where the marginal cost of the incremental facility equals or exceeds the marginal revenue from the facility, future development in terms of the efficiency of the enterprise, should cease.

It would seem that in the case of the Oldman River Basin, that point occurs when the Chin Pump is added. If its cost is averaged in with the other facilities and the marginal revenue it generates is included with the revenue generated by other facilities, the benefit/cost ratio is greater than one. However, considered by itself, its ratio is less than one. One further point should be noted. The total energy costs and depreciation charges for the Chin Pump do not seem to have been included in Anderson's calculations, probably because they were not available. Anderson (1978, p. 35) shows annual operation and maintenance costs of $168,000. In addition to this, Acres estimates annual depreciation costs of $535,600 and average annual energy costs of $863,000, when pumping approximately 105,000 acre feet per year. As noted previously, these costs are high and continuous (see Appendix 7).

The Environment Council feels that the Anderson study is an excellent technical work. It disagrees, however, with some of its basic assumptions and procedures, and, as provided by Anderson, these alternative assumptions can be tested by his sensitivity analysis. The Environment Council also notes that marginal analysis was neglected, although information to undertake such analysis was probably not available to Anderson at the time he undertook his work.

11. COMPENSATION

11.1 COMPENSATION AND EXPROPRIATION

Compensation for the land and property to be taken to construct new works, whether onstream or offstream, was a matter raised a number of times at the Hearings. The Management Committee found existing compensation policies unsatisfactory and suggested examination and revision to "allow for more flexibility in compensating landholders . . . based on the principle of fair and equitable settlement to the landowner in recognition of an individual loss to achieve a regional and provincial benefit" (p. 62).

No one at the Public Hearings supported the existing methods and levels of compensation, while 11 briefs suggested that compensation to displaced landowners should be at more than market value (briefs 1, 21, 23, 64, 67, 90, 102, 189, 194, 199, 202). These comments were not provided by the affected dryland farmers. In fact, the people directly affected at Fort Macleod, Three Rivers, and at offstream locations made the point very vigorously that their opposition to the structures was not because they wished to receive higher compensation, but because they did not wish to lose their land. The support for higher compensation came instead from Unifarm, representatives of irrigation districts, and irrigation farmers.

What was being voiced was a recognition that the taking of land was one of government's most extreme incursions into the life and liberty of citizens. The forcible taking of land goes against the conscience of most southern Albertans. They realize that it must be done in certain circumstances, but the reasons for doing so must be established clearly and overwhelmingly and they feel that compensation should be generous.

Everyone ultimately disposes of his land, through sale, death, or family transfer. However, it is done at a time dictated by personal affairs. When the government requires land, it may be at the least appropriate time for the landholder, who must suffer the trauma of change and major readjustment. It is not just a business that a farmer is conducting that provides certain cash flows; it is a web of friendships, established relationships with suppliers and markets, and a familiarity with the community and its supporting services. In a sale, all these factors are lost as well, but the sale takes place at the seller's initiative because of age, loss of interest in carrying on farming, or a desire to transfer ownership to a selected family member. The value of these elements is unquantifiable. Market values by their nature are transactions between a willing buyer and seller. Market values, therefore, give no indication of the compensation that an unwilling seller should receive, except that it is something more than the existing market level.

The briefs, although they identified this problem, did not suggest how it might be overcome. Discussions with the Land Assembly Division of Alberta Environment indicated that although it is possible (and is the practice of the Division) to compensate for any identifiable losses, such as reduction of farm size below the level of efficient operation of machinery and buildings, they are constrained by market values. The Land Assembly Division attempts to be "generous," but their definition of generous is necessarily constrained by being interpreted within a framework of market values and the desire to prevent wastage of public funds and inflation of land prices.

It is relatively easy for irrigators and other beneficiaries to be generous when it is provincial government funds that will be spent. One novel suggestion heard was that deeds to all benefiting irrigation farms might be put in a hat and drawn by lottery as compensation for a flooded out farmer. The lack of equity makes this impractical, but it does recognize a major problem of bringing home to those who benefit that a personal sacrifice is involved.

The suggestion was also made that trades of a farm for a farm might be made. The Land Assembly Division is willing to do so, but equivalent farms are difficult if not impossible to find, particularly those with valley bottom land. It should, however, be easier to find equivalent parcels for those displaced by offstream structures, particularly where irrigated land is involved, and trades should be used wherever possible.

The Management Committee also suggested the allocation of water rights "to irrigate up to 320 acres of land for each mile of canal or reservoir shoreline adjoining their land" (p.37). The Environment Council cannot endorse this proposal. The landholders adjacent to canals and reservoirs benefit substantially when these facilities are provided, if they can irrigate. If it is physically impossible to irrigate, compensation by way of water rights is meaningless and inequitable. The substantial area involved should also be noted. Fifty miles of canal would involve the allocation of water rights to 32,000 acres.

In the examination and revision of Alberta's land acquisition policy, the Management Committee called for substantial public input. This will undoubtedly be necessary, but it seems to the Environment Council that some important actions should precede it. There seems to be a dearth of information and comparative practical experience available to the public. Yet, compensation and expropriation must be a problem in all free societies. It may well be that in other jurisdictions in Canada, United States, and Commonwealth countries, other approaches and techniques have been tried and found helpful. An international conference on "Compensating the Unwilling Seller" that would bring together the widest possible range of experience and practice is desirable. Such a gathering should be designed primarily to produce information which would provide the essential background to future Public Hearings on compensation and expropriation. The public at present can do no more than identify that they find the present system of compensation and expropriation unsatisfactory, but in the absence of further information and possible choices, they cannot indicate a useful preference, other than the feeling that compensation be more generous.

In the meantime, the possibility of having to acquire land from unwilling sellers and the forced taking of property will have to be faced. The following guidelines are suggested.

1. Expropriation should be avoided, if at all possible.
2. The case for the taking of property should be established beyond all reasonable doubt. Many of the recommendations contained in this report are designed to do just that, establish beyond reasonable doubt that the land is required and that the benefits to be gained by society far outweigh individual losses.

3. The fewer people disturbed the better. It is not only in the case of virtual equivalents that choice should be swayed in favour of the structure or facility that disturbs the fewest people. A more costly, less effective facility is to be preferred if it disturbs fewer people.
4. Until a satisfactory alternative is found, which will not be soon, market-based evaluations will continue to be employed. The Environment Council urges the Land Assembly Division of Alberta Environment to err on the side of generosity in acquiring land from unwilling sellers. Certainly the incidence of speculation is not an important factor in the lands that need to be acquired. The people whose lands are required are exactly what they appear to be, *bona fide* farmers and other landholders with properties that they acquired with no thought of windfall gains or generous government cash settlements. Speculation, however, could become a problem in the future for other types of projects in other areas, increasing the urgency for long-term solutions to this problem.
5. In dealing with the Indian peoples, the question of unwilling seller does not arise. The Government of Alberta cannot take reserve land forcibly and any structural solution involving Indian lands is subject to this unique veto.

12. INDIAN RESERVES

12.1 INTRODUCTION

The Blackfoot Indians of southern Alberta named the Oldman River after the old man, Napi, the trickster/teacher of their legends. It is said that there is a place in the Livingstone Gap on the river where Napi bowled with the animals for sport before man came to the world. The current name Oldman River comes from the shortened form of "Where Napi Bowled" (H. Dempsey, personal communication).

The rivers played an important role in Indian life before the imposition of white administration. The current housing patterns on the Peigan and Blood Reserves do not reflect any link with traditional living sites. During the early years of this century, white administrators moved Indians to housing sites away from the traditional sites on or near the rivers and streams onto the windswept flats as part of the attempt to encourage agricultural development (H. Dempsey, personal communication). The scattering of houses away from water has certainly exacerbated the problems of water supplies for individual homes.

The significance of the phrase "as long as the rivers shall flow," which is attributed to the Indian Peace Treaties, indicates both the importance and the feeling of permanence attached to the rivers. The fact that that flow could be controlled, if not entirely stopped, has not gone unnoticed (brief 14). The archaeological evidence for the important role played by the rivers is strong (Lombard North 1978). Although there is easily discovered archaeological evidence outside the river valleys, direct archaeological evidence of occupation of sites on the valley floors is obscure. This could be due to the fact that the vegetation and flooding have obliterated evidence rather than an indication of lack of occupation and use. Stone cairns in the Gap (Holmgren 1972), and archaeological work in the area (Forbis 1960) continue to reveal the importance of the rivers to the original peoples.

Shortly after the Signing of Treaty Seven, the growing of vegetables on both reserves was very successful. A combination of weather problems and bureaucratic mismanagement unfortunately lead to failure within a very few years (Dempsey 1978). Thus, there is historical precedent for some of the projects proposed for the reserves, if they are carried out within the constraints of soil and climate.

The management of water resources on the Reserves cannot be ignored. The Peigan and Blood Indian Reserves and their timber reserves are the largest single land holdings in southern Alberta. Works critical to the operation of most of the irrigation systems of the Oldman Basin are on Reserve land. Problems on the Reserves due to failure of development on the Reserves to keep pace with the communities surrounding them spill over into those communities (brief 14).

The Management Committee foresaw irrigation development on both the Blood and Peigan Reserves. The view of the Environment Council is that a substantial development on the Blood Reserve is economic and desirable. Unfortunately, the possibilities on the Peigan Reserve appear to the Council to be very limited.

The goals and aspirations of any people determine the nature of any development they wish to undertake. No member of the Environment Council wishes to set goals for other cultures. If the goals decided upon involve economic improvement, the laws of economics prevail. Success will depend on sound plans, availability of capital, well-trained personnel and a strong motivation to succeed. Indian people have had both successes and failures in the projects they have undertaken. Failures have been due to a lack of one or more of the essentials for success. Lack of motivation would not so often seem apparent if frustration due to lack of capital and training was not so frequently the chief limiting factor.

12.2 THE BLOOD RESERVE

The Blood Indians have a major interest in and influence on the St. Mary system. Their Indian Reserve is the largest single property in the Oldman River Basin. The Reserve is bordered on the west and north by the Belly River, and on the east by the St. Mary River. The Belly River diversion dam sits on Blood land while the St. Mary Main Canal, from Waterton Reservoir and the Belly River Weir to St. Mary Reservoir, cuts completely across the Reserve. In addition, about one half of the St. Mary Reservoir sits on Blood land. The Blood Reserve is bounded by irrigation rivers, cut by irrigation canals, covered by irrigation compounds, and built on by irrigation structures. At the time these works were undertaken by the Government of Canada in 1950, the Indians were compensated in part by a cash settlement and in part by a promise to provide irrigation water rights to 25,000 acres in the northeast section of the Reserve. When the provincial government assumed responsibility for the St. Mary headworks from the federal government, they also assumed the obligation to provide water to 25,000 acres on the Blood Reserve.

The Blood Indian Band has been preparing itself to exercise this right. Band members have identified that the major economic development potential of the Reserve is agricultural, both dryland and irrigation. They have established a Band farm on dryland, under the management of a successful dryland farmer from near the Reserve. It has been successful and profitable and serves as a practical training ground for young men who wish to farm. They have also established an irrigation farm on bottom land near the Belly River. They have 300 acres of potatoes contracted to a processor who has been pleased with delivery and quality. Again, the farm is used as a practical training school and has been profitable.

They have established what is essentially an agricultural high school, where courses such as soils, farm management, and mechanics are taught. These courses have been recognized for credit by Alberta Education. A new modern shop has been constructed to give students practical experience in welding, electrical wiring, and repairing farm machinery. Admittance is limited, and successful graduates are guaranteed employment. If the rate of development were accelerated, more students could be admitted.

The Band has drawn up a comprehensive plan to develop both irrigation and dryland areas, and essentially has achieved a consensus among Band members on the plan and its priorities. All available Band funds are being used for agricultural development, and in the process roads development and other services have been curtailed.

Some 10,000 acres in the southern part of the Reserve are irrigable directly from the St. Mary Main Canal. This is easy to irrigate, but has a moderately high rainfall and a relatively short growing season (like the Foothills Irrigation Districts). The Band sees this as a low priority area, available to individual farms and farmers to develop or not as they see fit.

The large proposed project is in the northeast corner of the Reserve, and at one point is just across the river from the Lethbridge airport. Here, the climate and soils are both excellent for irrigation farming. This area would be irrigated from the St. Mary Reservoir. One coulee must be crossed to bring water to this area, and the Band has suggested that, rather than a siphon, a small dam be constructed in the coulee to transmit the water and act as a small storage reservoir. A preliminary estimated cost in 1976 for the canal and distribution system was $10 million. Alberta Agriculture estimates that this would irrigate 25,000 acres. The Indians are of the view that only 20,000 acres should be irrigated. The additional 5,000 acres are in the southwest corner of the block on heavier land with better rainfall. Alberta Agriculture identifies the soils to be irrigated as excellent, comparable with the SMRID (West). The department also points out that the drop between the dam and the project would be some 300 feet and that a pressurized pipe system is possible, at additional cost. There would be additional capital costs for machinery, buildings, and roads estimated at from $5 to $8 million.

All in all, it seems to be a fully feasible project. Particularly heartening is the approach of the Band, starting out in a small way with irrigation farming, training their people, and developing practical experience in irrigation practices.

A major remaining roadblock is the source of funding. If Indians were able to use their land as security, they would probably be able to raise funds for the project through conventional channels. Without such collateral that route is blocked. The federal government, which has responsibility for Indian peoples, would seem to be the obvious alternative source. The Band's experience in trying to obtain funds from this source can only be characterized as a "runaround." Although the Department of Indian Affairs acknowledges the soundness of the proposal, they had pleaded first that the Treasury Board was slashing, not expanding the budget. They then suggested that the Blood's proposal could not be considered until all reserves in Alberta had developed plans for economic expansion and there was general agreement among the reserves on all the plans submitted. The only interpretation that the Environment Council can put on this action is that funds for economic development will not be available from the federal government, no matter how sound the plan or urgent the need. The Environment Council's assessment is that the proposals of the Bloods are viable and their approach to development sound. They deserve to receive a level of support that would be available to them, were they not Indians. Elsewhere, the Council has suggested that irrigation districts should be supported to 75 per cent of the cost of rehabilitation of district capital works. The Council recommends that similar assistance be extended to the Blood Indians to enable them to proceed with their irrigation project and further suggests that loans at the rates provided to municipalities, presently 8 per cent, be available to cover the Band's cost sharing if needed.

It would be most desirable for the Bloods to petition the Irrigation Council to form an irrigation district. This would require a petition signed by more than 50 per cent of those on the Band rolls and the approval of the Band Council and the Minister of Indian Affairs as the trustees of the Reserve. There may be other reasons why the Bloods could not form an irrigation district, but they do not fall within The Irrigation Act. The advantage of forming an irrigation district is that the Bloods would then have available to them all the assistance that irrigation districts enjoy, and that, like other districts, their plans and budgets would be subject to the scrutiny and control of the Irrigation Council.

Alberta Environment would not be able to charge the Band irrigation district a wholesale water charge, as suggested for other districts, since they have already been granted water rights to irrigate 25,000 acres as part compensation for the structures located on their land.

If there are other legal impediments to the formation of an irrigation district, the provincial government, by direct agreement and contract, should attempt to provide them with equivalent status. The social and economic benefits to be gained by the Bloods, their neighbouring farmers and communities, and by the provincial government are too great to be missed or frittered away. The Environment Council has considered the precedent that might be set. However, if native peoples throughout Alberta had economic development plans as viable and as soundly based as the Bloods seem to have, support by the provincial government would be equally sound in those instances. The Environment Council has no knowledge of and can make no comments on the federal-provincial, constitutional, and jurisdictional aspects, except to say that if they inhibit support to the project, they should be renegotiated or removed as quickly as possible.

12.3 THE PEIGAN RESERVE

The proposed developments outlined by the Management Committee could affect the Peigans in two ways. First, it might be possible to develop an irrigation project on the reserve as part of their development program. Second would be to construct an onstream storage facility on Reserve property.

The Peigan Band requested Alberta Agriculture to carry out a preliminary survey of the potential for irrigation on the Reserve. This was done and a report prepared which identified that some 17,500 acres could be irrigated largely by the use of sprinklers. Soils characteristics were satisfactory, but the short frost-free season could limit economic returns. The source of water would be the Oldman River, either from a dam on the Castle River or at the Three Rivers site. The Castle River source was not costed out. Using water from the Three Rivers site would involve a pumping station and a canal to the southwest corner of the Reserve. The estimated cost of the project excluding the reservoir would be $1,050 per acre served. If the cost of the pumping station and the main canal were excluded, the cost would be reduced to $708 per acre served.

Even at the lower cost, the project is only marginally economic, considering climatic limitations on crops that could be grown, and is impossible unless a dam were built at the Three Rivers or Castle River site.

If, for whatever reason, an onstream storage reservoir on the Oldman River becomes necessary, the Brocket site on the Reserve deserves consideration. The question then becomes whether or not this would provide benefits to the Peigans. At the Hearings, they stated they would require at least five years to make a decision on this point (brief 91). Insofar as irrigation is concerned, a dam at this site would not improve the economics of the irrigation project referred to above. All water would need to be pumped for the entire area. Judging from other large-scale pump projects that have been examined, the Environment Council assumes that the costs would be prohibitive. Similarly, the use of the reservoir as a revenue-producing recreation area would seem to be of minor economic importance. Many recreation areas in the region are free or heavily subsidized. The Environment Council has not made a study of this potential— merely a judgement that it would be of minor importance.

In discussions with them, the Peigans expressed a sensible view that their first priority should be to develop their land resources. Because of their small land base relative to their population, it cannot be the ultimate solution to all their problems, but it is a good place to start. They expressed a desire to have their own people farm the cultivated land now leased to non-Indians, and to have some irrigation development to grow their own vegetables and help develop their livestock industry. Water, pumped from the river, is available for vegetable production, but is probably too costly for forage production. Small streams and coulees in the Reserve on both sides of the river might be dammed at small cost to catch spring run-off. This could allow at least some irrigation on suitable acreages of forage. This would help to assure a winter feed supply for their livestock.

The one remaining area of benefits is the value of the site, which has little agricultural value, but would be worth a substantial sum as a dam site. The money could be used for badly needed development projects, and to enhance the livelihood of the Peigan people.

While it is outside the terms of reference, the Environment Council wishes to comment on the Peigan Reserve and its people. Nowhere in the basin did the Council find a more urgent need for opportunities that would give hope to the young people. Peigan leaders are fully aware of these problems and have some sensible ideas for a measure of improvement. It is hoped in the ongoing negotiations between the Government of Alberta and the Peigans that a partnership can be established which will not only resolve present conflicts, but will also lead to economic development that will provide needed opportunities for the Peigan.

13. RESEARCH AND EXTENSION

13.1 RESEARCH AND EXTENSION

The Management Committee made a number of recommendations relating to research and extension services. In the area of research, it gave a detailed list of areas of high priority. These had to do with soil-water and plant-water relationships, testing of materials for conveyance and measuring water, demonstrating the benefits of soil drainage, developing an integrated communication network for a scheduling service, and a plant breeding program for crops suited to irrigation.

In the area of extension, the Management Committee recommended that particular attention should be given to systematic soil moisture monitoring, irrigation scheduling, land classification, soil drainage and improving communication between farmers and irrigation district operators. It also stated there was need for educational programs and demonstration activities to induce water-conserving technology, and pointed out that every effort should be made to change the current public perception that water is a free and abundant commodity in the Oldman River Basin. The Management Committee proposed that much of this could be implemented with a $5 million research and demonstration fund through Alberta Agriculture.

The Environment Council supports research and extension, but cannot support the proposed fund on the basis of administrative principles. The total budget of Alberta Agriculture is a responsibility of the provincial legislature, including funds for research and extension. The allocation of these funds is determined by the Planning and Research Secretariat, which identifies priorities in consultation with the agricultural industry. To the Council, this seems to be a sound way to administer the always-scarce research dollars allocated by the legislature and the personnel available. As representatives of an important section of the agricultural industry, the irrigation districts are in an excellent position to establish what they consider to be priority areas, and to present their view to the Planning and Research Secretariat.

The objections of the Environment Council to allocating funds appropriated by the legislature to specific projects or areas is not in contradiction to a previous recommendation for a fund to be used for specific purposes. In the latter case, the monies are not appropriated by the legislature, and their users will not be employees of the provincial government, but rather people with ideas and expertise outside of government circles. The Planning and Research Secretariat, by administering all funds, is in an excellent position to see that co-ordination occurs without inhibiting the ideas of anyone.

The value of investment in research and development can only be realized when these results are translated into applications or in the market place. The nature of research is such that success cannot be guaranteed. For significant advances to be made, some high risk/high gain research must be supported. Therefore, in evaluating research and development proposals, the links to application and the market place, while important, should not be the overriding criterion. With that caveat in mind, the Environment Council recommends that those preparing research and development proposals, and those reviewing them, keep in mind the essential links between research and development and application and markets. Further, government and the private sector should start programs to bridge the gaps between research and development efforts and the world in which the results would be used.

The Environment Council was impressed by the research that has been carried out, and that which is in progress. The Lethbridge Research Station is one of the largest in Canada. The integration of Alberta Agriculture and Canada Agriculture personnel in the excellent facilities at the federal station in Lethbridge is an example of federal-provincial co-operation that is practical, efficient, and beneficial, both to the federal and provincial governments and to their clients, the farmers of western Canada. In addition, Alberta Agriculture has a specialized Research Station at Brooks. Smaller facilities at Bow Island and Vauxhall are, like those at Brooks, almost entirely devoted to irrigation research of various types. The Environment Council was impressed by the research that has been carried out and that which is now in progress, but has no opinion as to whether the present programs are adequate or require additional funding or personnel.

Throughout this report, a few suggestions have been made as to where additional work seems warranted.

In another section, the lack of basic data on the operation of irrigation systems was noted. There is only imperfect and anecdotal knowledge about the amount of water placed in the irrigation network, the precise nature and scale of losses in the transmission, the amount of water actually delivered to the farm, and the amount of spillage and return flows. The day-to-day details of the operation of the system are carried in the minds of a few dedicated district employees. Accurate quantitative material available for analysis by research personnel seems desirable. Indeed the distribution network would seem to be a logical candidate for systems analysis to provide for better planning and operation. Systems analysis requires basic quantitative material that is not yet available.

Of lesser significance, but nevertheless importance, is the research facility at Bow Island. The Environment Council is impressed with the work underway, and the potential of this area for crops requiring high heat units. The Council is not prepared to recommend specific expansion of the work of this facility, but is prepared to recommend that the site now being leased, or a suitable alternative, be purchased. A degree of permanence is needed to warrant making available special irrigation facilities and other improvements.

There are many institutions and people involved in the extension services in southern Alberta. Alberta Agriculture provides an extension service that is used by irrigation and dryland farmers as well as agri-business. This service provides information on the wise use and conservation of water, and advice and assistance to the irrigation districts. The importance of a good data base and the role of metering have already been mentioned, but seepage and salinization which is often collective rather than an individual responsibility would seem to be an important area of concentration for extension services.

Another area in the public sector is the research staff, who frequently perform an extension function. They are usually willing to assist any farmer who has sufficient motivation to approach them, and are normally willing to address any forum or workshop that will listen to them.

Another group which provides an extension service is that of the private firms which provide advice on soil salinity, fertility, and irrigation scheduling for a fee to local farmers. The motivation of the private firms is to promote sales and generate a profit, so they have a real incentive to have the farmers that subscribe to their service achieve better yields and lower costs and thus justify the purchase of the service.

Most farmers who are growing contract crops have the company fieldman to call upon. In most instances, he regularly supervises the preparation of the land, the seeding, the irrigating, and the harvesting of the crop. These are experienced people who are highly motivated to see that the producer is successful and thus capable of delivering large quantities of produce that meet quality standards.

One further type of private extension service was illustrated by briefs presented at the Public Hearings by the equipment dealers and drainage companies. The sprinkler irrigation equipment dealers (brief 99) indicated that they custom-design pivot installations on a farm-by-farm basis. The success of their fieldwork is indicated by the speed and rapidity of the penetration of sprinkler systems on irrigation farms. The benefit of soil drainage has been demonstrated to the extent that in 1978, four installation contractors in the Oldman River Basin installed a little over one million feet of tile drainage with 75 per cent on dry land (brief 68). While it is true that equipment suppliers are interested in selling their products, any farmer who has any doubt about the proposal given to him can always check it with an engineer from Alberta Agriculture.

That the private sector is assuming the extension function is a sign of a maturing and properous agricultural industry. This is occurring in all phases of agriculture, but particularly in irrigation in southern Alberta and is a desirable trend that should be encouraged. This means that the role of extension in Alberta Agriculture is enhanced. It leaves the routine to others, and allows the extension specialists to concentrate their efforts on major problems of general interest.

14. RECOMMENDATIONS

14.1 INTRODUCTION

Recommendations have been developed throughout the report where they arise in the normal course of the discussion. They have been collected here for the convenience of the reader, who is urged to refer to the original discussion in the report for the background and analysis that led to the recommendations.

14.2 PRESENT WATER MANAGEMENT

ADMINISTRATION OF IRRIGATION

Authority for administration of irrigation is shared by two provincial departments--Alberta Environment and Alberta Agriculture. Alberta Environment is responsible for the construction, maintenance and operation of headworks, the maintenance of water quality, and the licensing of all water users, including private irrigators. Alberta Agriculture provides direct assistance to the irrigation farmer on soil, salinity, farm equipment, and a host of other factors. Both provincial departments have delegated much of their administrative decision-making to the Irrigation Council which, among other things, approves expenditures by irrigation districts, distributes provincial cost-shared funds, and approves district rehabilitation plans and irrigation land classification standards.

The Irrigation Council, appointed by the Minister of Agriculture, is composed of two senior civil servants, one each from Alberta Environment and Alberta Agriculture, with the other five members being practical irrigation farmers from southern Alberta. The Council is supported by a small secretariat provided by Alberta Agriculture. The provincial government is to be congratulated on the establishment of the Irrigation Council. It has been granted wide and extensive real powers to deal with the management of irrigation agriculture. The Irrigation Council solves many of the problems of the regional devolution of powers, since most of the important decisions are made in southern Alberta by men who are intimately and practically familiar with the problem. This role and the work they undertake should be more widely understood by their clients, the irrgation farmers, government officials, and the public at large.

Recommendation

1. The Irrigation Council should prepare an annual report for wide public distribution identifying the work they have undertaken during the current year, the plans and budget they have considered, and a review of the current and anticipated problems in irrigation agriculture in southern Alberta.

IRRIGATION DISTRICTS

District boards are responsible for the day-to-day management of irrigation works within irrigation districts.

Recommendations

2. It is extremely difficult for the individual farmer to obtain redress for damage to his land originating in seepage from irrigation works. The Environment Council, however, appreciates that the best cure is not compensation for damage done, but

the elimination of the source of damage. When the rehabilitation program is completed, the shielding from claims for injury provided by the acceptance of the "Ditch Rehabilitation Plans" should be ended, and sections 178, 179 and 180 of the Irrigation Act repealed. In the meantime, the moral obligation, that the districts have accepted, to provide prompt settlements in the case of operational spills, overflows, and serious seepage problems should be continued. In particular, priority should be provided to those injured whose land lies outside irrigation districts.

3. Irrigation districts charge new irrigation acres added to the assessment rolls a 'water right', as a contribution to capital expended by the district. Irrigation districts normally assess development costs, over and above the water right charge, to the additional acres. The Environment Council believes this is a desirable approach, and recommends its continuation.

14.3 THE STUDY AREA

PHYSICAL SETTING

The Oldman River Basin is a semi-arid land, where irrigation is required to develop crops to their full potential. The need for and potential of irrigation increases from west to east in the basin. The Brown Soil areas, with less than nine inches of rainfall in the growing season, are the least productive under natural conditions, but, because of the long frost-free period and high heat units, have the greatest potential for the widest range of irrigated crops.

Recommendation

4. Priority should be given to irrigation east of Lethbridge.

ENVIRONMENT

The most important environmental factor in the Oldman River Basin is diversity—of habitats, ecosystems, topography, and the contrast between arid and well-watered areas. Anything that contributes to diversity should be encouraged. Up to a point, irrigation, by adding the contrast of lush green fields to a brown, arid landscape, contributes to diversity. However, a continuous, contiguous irrigated area would be undesirable from an environmental point of view.

Recommendation

5. Land owners should be encouraged to maintain areas unsuitable for cultivated crops in ways which would add to diversity and provide shelter for wildlife. The Environment Council endorses the free provision of seedling trees for shelter belts by Alberta Agriculture. (See Section 3.2.)

RECREATION

Attractive recreational areas are possible at the interface of water and land, along rivers and lakes, both natural and man-made. Through irrigation, opportunities are created to introduce water into an otherwise arid landscape and to establish water-based recreation where, before, none existed. Unfortunately, the least attractive recreation-based water areas are those subject to the greatest fluctuation and drawdown. Balancing reservoirs with moderate fluctuation, such as Park Lake and Henderson Lake are attractive recreation features. Deep, steep-sided reservoirs with widely fluctuating water levels, such as the one at Chin Coulee and those proposed for Forty Mile Coulee and the on-stream dams are only marginally attractive for recreational purposes. Recreation planning is something that requires very substantial input from the public that will utilize the facilities. Many opportunities will be created to improve recreational facilities during the development and enlargement of reservoirs.

Recommendations

6. Planning should commence immediately for water-related recreation in the Oldman River Basin. The Environment Council does not favour the creation of a new administrative body to undertake this task. Instead, it recommends the regional planning commissions in the basin, namely, the Oldman River Regional Planning Commission and the Southeastern Alberta Regional Planning Commission create regional recreation plans. These bodies already have representatives of all the affected municipal administrations in the basin. Technical Subcommittees of the commissions could be an appropriate mechanism. If necessary, government representatives and representatives from the irrigation districts where facilities would be constructed could be added to the subcommittees. The major task of the Technical Subcommittees would be to develop plans for water-based recreational facilities. Public consultation should be an important element in the development of these plans, so that the views of potential users are fully considered. (See Section 3.3.)

7. The Environment Council recommends the minimum flow criteria on the St. Mary, Belly, and Waterton Rivers not be increased above 30 cfs as the Management Committee recommended for the far future. The anticipated fisheries benefit is not considered adequate when balanced against the increase in irrigated land south of the Oldman River.

8. The Environment Council recommends that Alberta Environment not retain the services of a reservoir limnologist. Qualified personnel already exist within the Fish and Wildlife Division and such duplication is unnecessary. The Council also feels that stocking large reservoirs is unwise due to high costs and poor likelihood of success.

9. In the enlargement of Keho Reservoir, the existing park and golf course will be substantially affected. Park replacement at equal levels of quality is imperative, and should be considered part of the compensation required for the construction of this facility. If possible, provincial park standards should be attained. In particular, the replanting of the shade trees from Keho Park, or their replacement by trees of equal stature, should be provided for by the provincial government. Compensatory land should be convenient to the existing golf course and developed to the condition of the present course.

10. The Environment Council has no detailed recommendations for the development of water-based recreation facilities in the basin as that job is best left to the regional planning commissions. However, there should be generous provincial funding available for beautification and construction of associated recreation facilities. (See Section 3.3.)

14.4 ELEMENTS OF WATER MANAGEMENT IN THE OLDMAN RIVER BASIN

Water management is an amalgam of many things. It involves not only the use of water, its impoundment and conveyance, but the uses to which water is put in irrigation agriculture, for recreation, as a vital service to industry and homes, and as part of the environment, particularly in an arid and semi-arid environment. The overwhelming current consumptive use of water in the Oldman River Basin is for irrigation and that will not change. However, a number of elements must be considered in the use of water that affect, shape, or constrain its utilization.

Recommendations

11. Within the limits of water availability, Alberta Agriculture, through the Alberta Soils Classification Committee, should continue to work towards the classification of soils for irrigation that recognize the unique conditions of southern Alberta.

12. In addition to the physical factors that are already allowed for, such as soil structure, drainability, fertility, topography and climate, provision should also be made for two other major factors:
    a. the cost of conveying water to the soils in question, and
    b. the increase in productivity that would occur if the soils were irrigated.

13. The Irrigation Council should be responsible for the adoption of the irrigated soil classification standards for Alberta. On the basis of this classification, it should prepare a priority listing of "acres to be irrigated" which would be updated as new information becomes available.

WATER ALLOCATION

There are a number of demands on the tributaries of the South Saskatchewan River. These demands range from federal-provincial and international contractual obligations (apportionment), through municipal and industrial water uses, to stream flow maintenance for recreational and fishing uses. Each demand must be carefully gauged to identify the restraints on the use of water in the Oldman River Basin.

Recommendations

14. The Government of Alberta should strongly resist attempts to change the accounting period for interprovincial water apportionment from annual to more frequent periods. Saskatchewan has extensive storage on the South Saskatchewan River at Lake Diefenbaker and water demands are not great in the short stretch of the South Saskatchewan River from the Alberta-Saskatchewan border to Lake Diefenbaker. (See Section 4.3.)

    Recommendations throughout this report are based on the assumption that 75 per cent of the mean annual flows of the Red Deer River and 50 per cent of the mean annual flows of the Bow River will be available to meet interprovincial apportionment. At the Public Hearings both the Red Deer Regional Planning Commission and the Eastern Irrigation District pointed out that they were unsure whether this provided sufficient water in the far future to meet what they consider to be their legitimate needs.

15. The Environment Council recommends that under no circumstances should the total irrigated acreages recommended in this report be exceeded before a comprehensive South Saskatchewan River Basin water management plan is completed, commented on by the public throughout the South Saskatchewan River Basin at Public Hearings, and adopted by the province as the long-range plan for water management in the South Saskatchewan River Basin. (See Section 4.3.)

    In the view of the Council, in order not to prejudice development in one subbasin by activities already underway in another, the plan is needed much more urgently than indicated by the Management Committee.

16. The Environment Council endorses the present priorities for consumptive water allocation in the province with domestic water users with first priority, municipal users second, agriculture third, and industrial users fourth. The Council recommends continuation of the use of these priorities, however, it should be noted that the present industrial consumption of water is so small in comparison to irrigation that it should be possible to provide for industrial requirements without affecting irrigation use.

17. The communities of the basin should be models of good water stewardship. Since they are urgently required, plans for water conservation as a normal, prudent practice in a water-short area should be developed.

18. Stream flows in the Oldman River measured at Lethbridge should be based on a minimum flow criteria of 360 cfs. Though these stream flows can only be assured on an average monthly flow basis, operationally, every effort should be made to assure that minimum instantaneous flows fall below this level as seldom as possible during the summer months. (See Section 4.3.3.)

    For the Waterton, Belly, and St. Mary Rivers, minimum flow criteria of 30 cfs on a mean monthly basis should be the objective. It would be possible, as the Management Committee suggests, to guarantee greater stream flows than this in these rivers. Neither at the Public Hearings, nor in its deliberations, did the Environment Council discover any compelling reason why the minimum stream flow criteria in these rivers should be higher than 30 cfs. Higher flows might be beneficial to the fisheries in these rivers, but there is no evidence that a major fishery presently exists or that its development would be warranted. (See Section 4.3.3.)

19. The Fish and Wildlife Division of Public Lands and Wildlife should undertake studies in the Oldman River to identify the stress placed on the fisheries by the minimum stream flow criteria suggested. The Water Balance Model now provides a forecast of minimum stream flow characteristics under all likely future conditions. The incidence and frequency of low flows can be identified and the consequence to the fishery at least tentatively assessed. It is important that work begin now so that this information can be contributed in a timely fashion to the South Saskatchewan River Basin study. (Section 4.3.3.)

20. The Environment Council feels that the "failure criteria" adopted by the Management Committee of a frequency of occurrence of a water shortage of no greater than 10 per cent one year in ten, and no years with water shortages greater than 20 per cent of requirements more than once within forty years, are stringent. However, their adoption is recommended as a useful tool in the allocation of a scarce resource. Nothing that the Council recommends exceeds these criteria, though it is not felt that a 10 per cent shortage, particularly as calculated in the Water Balance Model on a cumulative basis, would be a serious hindrance to irrigation agriculture. (See Section 4.3.4)

PRIVATE IRRIGATION

Recent information suggests private irrigation is already using water at a rate exceeding that suggested in the Management Committee report. Although water availability will limit expansion of private irrigation, rising energy costs and possibly, a shortage of suitable locations, are considered more significant.

21. The Environment Council recommends that no additional licences be granted for private irrigation until Alberta Environment or Alberta Agriculture, or both, is satisfied that sufficient water is available. If, after this review, adequate water is available, priority should be given to applications east of the confluence of the Little Bow and Oldman Rivers.

22. The Environment Council supports existing interdepartmental and public review procedures for private irrigation licences, but is uncomfortable with follow up procedures after licences are granted. Consequently, the Environment Council recommends that Alberta Environment and Alberta Agriculture review their administrative procedure with the objectives of providing practical methods of monitoring water uses and of putting into effect mechanisms that would enable them to ration users in an equitable manner if low flows make rationing necessary.

23. The expansion of private irrigation in the future is subject to the constraint of rising real costs of energy. Under these circumstances, the Council recommends that private, onstream irrigation projects be treated as a residual without special and increased water allocations and assigned whatever water is available after other users who have more stable input cost prospects are satisfied.

WATER QUALITY

The basic water quality of the Oldman River is relatively good. Alberta is in the fortunate position that with relatively little effort and expense it can avoid the water quality problems which other areas and other river systems have experienced.

Recommendations

24. Water quality objectives should be reviewed and adjusted periodically to accommodate increases in amounts of pollutants released or newly identified problems.

25. Wastewater treatment systems in the Crowsnest Pass should be upgraded in terms of lowering biochemical oxygen demand and disinfection of wastewater. Tertiary treatment is not presently required in the Crowsnest Pass, but will likely be needed in the future as population and tourist traffic grow.

26. Utilizing existing programs for financial and technical assistance from Alberta Environment, the City of Lethbridge should move immediately to install adequate tertiary treatment or wastewater utilization systems, or both. The unidentified pollution source near Lethbridge should be identified and dealt with quickly.

27. Calgary is a major contributor to phosphorous loading in the Bow River and, subsequently, the South Saskatchewan River. The Environment Council believes that, although little detailed information is available, it is unreasonable to expect downstream communities (for example, Medicine Hat) to provide tertiary treatment until upstream phosphorous loadings are substantially reduced. Hence, the Council recommends that Alberta Environment with assistance from the Alberta Municipal Sewage Treatment Program give priority to Calgary's phosphorous loading problem. After substantial progress has been made, the necessity of tertiary treatment in Medicine Hat should be assessed.

28. Effective disinfection must be applied to all sewage outlets. The possibility of disinfection with ozone should be fully investigated by Alberta Environment.

29. The Environment Council endorses the principle of wastewater utilization treatment systems and recommends their establishment wherever feasible, for both the disposal of normal municipal wastes and animal wastes from feedlot operations. The Environment Council fully endorses the statement of the Management Committee that: "The Committee is of the view that as agricultural, industrial, and municipal development accelerates and the population increases, steps must be taken to reverse the already critical trend toward water quality deterioration. The Committee is firmly convinced that recycling nutrients is preferable to the dissipation in, and ultimate degradation of, a biologically viable river system. The present practice of discharging wastes into watercourses is no longer a satisfactory means of disposal in an area like southern Alberta, where water supply is critical. More environmentally acceptable solutions must be employed" (p. 40).

30. Alberta Environment should undertake to identify potential storm runoff water quality problems and their solutions.

31. The guidelines of Alberta Agriculture Confinement Livestock Facility Waste Management: Code of Practice, 1973, should be revised to take greater account of the drainage and flood characteristics of individual sites.

32. The Environment Council also endorses the Management Committee recommendation: "Existing feedlots that are contributing to pollution of watercourses should be required to contain their runoff and dispose of it through wastewater irrigation or, where this is not practical, should be required to move the operation a designated distance away from watercourses" (p. 63). The Council recommends, however, that if there are identifiable cases where water pollution problems can only be solved by expensive and disruptive relocations that Alberta Environment and Alberta Agriculture should develop a cost-sharing program to assist farmers to relocate. (See Section 4.4.2.1.)

33. The Environment Council endorses and supports implementation of the Management Committee recommendation: "No new feedlots should be permitted to develop adjacent to watercourses" (p.63). However, the terms *adjacent* and *watercourses* should be carefully defined by Alberta Environment and Alberta Agriculture in consultation with the agricultural community.

WATERSHED MANAGEMENT

Watershed management is critical in regulating the quantity, quality, and timing of release of water. To maintain quality and retard release of snowmelt, native vegetation in the watershed should be retained in as unaltered a state as possible. However, vegetation manipulation can increase water quantity, though at some sacrifice of the other objectives.

Recommendations

34. By 1985, Alberta Forest Service, Alberta Environment, and Alberta Fish and Wildlife should decide the appropriate approach to watershed management in the Oldman River Basin. The decision should be based on a careful evaluation of the tradeoffs between water quantity, water quality, and timing and the direct and indirect costs involved in vegetation manipulation.

35. The Environment Council, along with the Management Committee recommends that: "Surface disturbing activities such as road construction, pipeline construction, and mineral extraction and development must be closely regulated to prevent deterioration of the watershed" (p. 64).

GROUNDWATER RESOURCES

The Environment Council does not envision groundwater resources playing a major factor in irrigation, but they can be important for municipal, domestic, and industrial water users.

Recommendations

36. The possibility of using groundwater either as a primary or secondary supply for the Crowsnest Pass communities should be investigated by Alberta Environment.

37. The City of Lethbridge should investigate the possibility of utilizing the nearby aquifer, particularly for industrial purposes.

38. In view of the current difficulties the Town of Bow Island is experiencing with its water supply, it should, in conjunction with Alberta Environment, undertake an investigation of the possibilities of an alternative groundwater supply.

39. The Environment Council endorses the Managment Committee recommendation that "Current mapping and evaluation of groundwater capabilities . . . should continue throughout the basin at the present level of activity" (p. 64).

40. The Environment Council recommends that the Alberta Research Council conduct further research on groundwater recharge mechanisms in the foothills and plains. This research would have implications for the artificial recharge of aquifers, use of riparian aquifers, improved utilization of groundwater and surface water resources. (See Section 4.6)

ENERGY GENERATION

Energy generation would be a supplementary benefit in the construction of facilities for the storage and conveyance of water for irrigation, rather than the prime objective of construction.

Recommendations

41. The Environment Council supports the recommendation of the Management Committee that installation of the electrical generating capacity at the Raymond Chute and other major drop structures in the irrigation districts should be investigated and undertaken where practical.
    a. Raymond Chute which has a drop of 97 feet with a design flow of 3,250 cfs appears economically viable. Chin Coulee Chute with a drop of 112 feet and design flow of 1,783 cfs as well as the proposed Forty Mile Coulee Chute with a drop of 26 to 76 feet and design flow of 1,000 cfs should also be investigated.
    b. When the canal between Milk River Ridge and Chin Coulee is rehabilitated, Alberta Environment and the electrical utility should examine the possibility of combining the six drop structures in Sections, 1, 12, 13 and 24 of Township 6, Range 21, West of the Fourth Meridian. Combined, these structures have a drop of about 150 feet and a capacity of 3,200 cfs. Two drop structures in Section 18, Township 8, Range 18, West of the Fourth Meridian, with a drop of 44 feet and a capacity of 2,000 cfs, should be investigated to see if power production is possible. (See Section 4.7.)
    c. An onstream dam at Fort Macleod with the expanded head and capacity suggested by Klohn Leonoff (1978b), could become economically viable as a power generation site.

42. If electrical generating facilities are built, the power utility involved should operate the facility and the energy generated should be fed into the Alberta interconnected system for use as required.

43. The use of windmills and wind-generated power for lifting drainage waters back into canals for re-use should be investigated by Alberta Environment and the irrigation districts.

44. The EUPC should investigate the use of offstream reservoirs as possible sources of cooling water for thermal power generation. Investigations should also give due consideration to social and environmental impacts.

14.5 MARKETS

Markets are critical to the success of agriculture, including irrigation agriculture. The Environment Council is optimistic with respect to markets, although it is acknowledged that forecasting market trends is a hazardous and error-prone occupation. The confidence of the Council rests basically on the wide range of crops that can be grown under irrigation, particularly in those parts of the basin with high heat units and an extended frost-free period, coupled with the ability and enthusiasm of producers and processors and their own confidence in their ability to grow and market profitably.

14.6 REHABILITATION

There was complete agreement at the Public Hearings that rehabilitation of existing conveyance structures and facilities was of the highest priority in the development of irrigation in southern Alberta. There were two major reasons for this: first, the additional water that would be available if transmission losses were reduced; and second, the reduction in seepage and the consequent reduction in salinization. The Environment Council is convinced that rehabilitation will make more water available for irrigation, but the poor data base and contradictory information make a precise figure for additional irrigated acreage unattainable. The Council does agree with the Management Committee target of an overall district efficiency of 60 per cent, based on 80 per cent delivery efficiency and 75 per cent farm efficiency.

Recommendations

45. Rehabilitation standards should be the responsibility of the Irrigation Council. The levels should be prudent, yet recognize the objective of an 80 per cent delivery efficiency. Estimated costs to achieve this level in district delivery systems range from $100 to $160 million for the Oldman River Basin. (See Section 6.2)

46. The Environment Council recommends a change from the present 86/14 cost-sharing formula to 75 per cent (provincial)/25 per cent (irrigation district) and removal of the limit of capital available on a yearly basis.

    The reasons for this are:

    a. The investments required are large. If cost sharing is too generous, there will be a temptation to invest too heavily. The Council feels that when irrigation farmers, through their irrigation districts, must provide 25 per cent of the cost of rehabilitation they will invest wisely, choosing no more than is required to provide a suitable conveyance system. Hence, market discipline is substituted for capital rationing.

    b. New information on the distribution of the benefits of investment in irrigation works is now available. Previous economic investigations a decade ago on behalf of ARDA identified that 11 per cent of the benefits of irrigation investments went to the primary producer with the remainder to local, provincial, and national levels. Recent work by Anderson (1978), using updated data and analysis, suggests that the primary producer receives 40 per cent of the benefit while 60 per cent is received at the regional, provincial, and national levels.

    c. Drainage, which is important to agricultural success in other parts of the province, is assisted at no more than 75 per cent. Equity suggests that the levels of support should be similar.

47. In order to ease the impact of the 75/25 cost-sharing formula, the Environment Council (Section 6.5.1) recommends a staged program as follows:
1980 province 82 per cent, irrigation districts 18 per cent
1981 province 78 per cent, irrigation districts 22 per cent
1982 province 75 per cent, irrigation districts 25 per cent

48. The Environment Council recommends that the district rehabilitation program be the first priority for water management in the Oldman River Basin and be designed to reach completion no later than 1995. This should be considered a "one-time investment" by the province. After rehabilitation is complete, district works would become the continuing responsibility of irrigation farmers and their district boards.

49. The Environment Council recommends rehabilitation of the irrigation headworks which are the responsibility of Alberta Environment. The Council further recommends that the definition of headworks be changed to include:
a. North of the Oldman River—Mud Lake
b. South of the Oldman River—the St. Mary Main Canal from Milk River Ridge Reservoir to the outlet of Sauder Reservoir and associated storage works (Chin Coulee Reservoir, Forty Mile Coulee Reservoir, and Sauder Reservoir).

The only practical basis of rehabilitating the major delivery systems in the basin is for the Alberta government to assume the total financial responsibility. The estimated cost of this responsibility (in 1978 dollars):

Rehabilitation:	
LNID Main Canal	$ 45.0 million
SMRID Main Canal	40.0 million
	85.0 million
Storage:	
Keho Lake	$ 6.0 million
Mud Lake	24.0
Forty Mile Coulee	36.0
Chin Coulee (tentative)	32.0
	$ 98.0 million
Total	$ 183.0 million

In addition to these costs are the costs of rehabilitation of existing headworks of Alberta Environment, the Brocket Weir, and St. Mary headworks for which no cost estimate is available.

The Government of Alberta should be responsible for the construction and maintenance of the headworks as newly defined. However, the detailed daily operation of the system from Milk River Ridge Reservoir to Sauder Reservoir should continue as a contract to the St. Mary Irrigation District, as is the present practice in the Lethbridge Northern Irrigation District, with respect to its main canal.

50. The Environment Council recommends that irrigation districts served by these headworks be charged a wholesale price for water. The Council recommends this charge be 50 cents per acre foot of water delivered from the headworks to the irrigation districts. This charge would not apply to Mountain View, Leavitt, Aetna, and United Districts, as efficiency improvement is not feasible, or for private irrigators, due to difficulties with measurement and enforcement. It would not apply to the Blood Reserve as the provincial government assumed an obligation to provide water to 25,000 acres when it took control of the St. Mary headworks (see Section 12.2).

The reasons for the charge are:
a. to emphasize the value of water and to provide a further rehabilitation incentive,
b. a recognition of the broader level of provincial service to the irrigation districts, and
c. to create an "Efficiency Fund."

51. Concerning the "Efficiency Fund" the Environment Council recommends:
a. the fund be administered by the Planning and Research Secretariat of Alberta Agriculture;
b. proposals falling within the guidelines may be made by anyone, including individuals, companies, irrigation districts, producer associations, or universities;
c. these proposals be submitted to the Irrigation Council for appropriate comment;
d. the Irrigation Council would forward the proposals to the Planning and Research Secretariat who would access the necessary expertise to evaluate the proposals and would advise the Irrigation Council of their approval or otherwise;
e. when funds are available, the Irrigation Council and Alberta Agriculture would publicize the existence of the fund and the guidelines for its use.

Innovative ideas for improving agriculture in southern Alberta can originate with anyone from the practical farmer to the university laboratory worker. If it looks promising, the idea should be supported whether that support is for basic research, a pilot project, a demonstration project, or a test run.

52. The Environment Council recommends that farmers requiring individual scheduling services use the private sector rather than expect government to provide these services. (See Section 6.5.2.)

53. The Environment Council recommends that where major operational points in the irrigation districts are not presently metered, metering commence. This is to provide a means of levying the 50 cent per acre foot of water charge (see Recommendation 50) and to improve the water use information base. As the benefits of this metering are widespread, it is considered eligible for the 75/25 cost-sharing program. (See Section 6.5.3.)

14.7 IRRIGATION EXPANSION SOUTH OF THE OLDMAN RIVER

The basic problem with irrigation expansion south of the Oldman River is a greater number of suitable, relatively inexpensive irrigable acres than there is water available to irrigate them.

Recommendations

54. The Environment Council concludes that the present practical limit on irrigation expansion in the St. Mary Project is the water available from the Waterton, Belly, and St. Mary Rivers. At present efficiencies, this water is capable of irrigating about 495,000 acres in the St. Mary Project assuming minimum flow criteria of 30 cfs releases from these rivers (see Recommendation 18).

55. The Chin Pump is the critical transfer point for bringing water from the Oldman River to the St. Mary Project. Present annual operating costs and the expectation of rising costs of energy indicate that construction of Chin Pump is not warranted and, therefore, is not recommended.

56. The priority demands on this available water should be:
    a. irrigation for the Blood Indian Reserve. There is a contractual obligation to provide water to irrigate 25,000 acres on the Blood Indian Reserve as partial compensation for constructing irrigation headworks on their lands. The Bloods currently have viable plans to utilize water sufficient to irrigate 20,000 acres. They should not be subject to the 50 cent wholesale water charge, since the promise of water takes historical precedence.
    b. expansion of irrigation in the Taber and St. Mary River Irrigation Districts. On present evidence, irrigation seems more profitable in the Taber Irrigation District, but as the St. Mary River Irrigation District (East) matures, its long-term potential should be considered at least equal to that of Taber (see Sections 7.5 and 7.6).

    Irrigation expansion in the Magrath and Raymond Irrigation Districts should not be encouraged.

57. The Environment Council recommends that the first priority in the construction of major irrigation works is the rehabilitation and enlargement of the St. Mary Main Canal from Forty Mile Coulee Reservoir to Sauder concurrent with the construction of about 70,000 acre feet of storage in the vicinity of Forty Mile Coulee. The Council has been made aware of alternative proposals at Yellow Lake. It has no information on this engineering alternative and the environmental and social impacts of the Yellow Lake proposal. The Council finds it difficult to believe that the advantages of Yellow Lake are so superior that it would be worthwhile to go back to obtain the essential social and environmental data and the necessary public consultation to evaluate theYellow Lake proposal. The Public Hearings indicated overwhelming support for the Forty Mile Coulee proposal with only minimal, relatively easily mitigated opposition. Detailed planning for the Forty Mile Coulee facility should bear the following factors in mind:

a. drainage in the Grassy Lake-Yellow Lake area, particularly the possibility of returning excess water to the St. Mary Main Canal for irrigation re-use.
b. the possibility of a separate, small site, associated with Forty Mile Coulee Reservoir dedicated primarily to recreational purposes.
c. the 70,000 acre feet capacity proposed for Forty Mile Coulee is an approximate guideline. Detailed investigation may increase or decrease the size of storage.
d. the proposed canal capacity of 1,200 cfs above Forty Mile Coulee should be reassessed from the point of view of (i) accommodating snow melt, spring floods, or heavy flows during wet periods; and (ii) possible enlargement of Chin Coulee Reservoir by 140,000 acre feet.

58. A decision on the enlargement of Sauder Reservoir should be based on its contribution to operational efficiency. Its need could be established either through experience obtained after the Forty Mile Coulee Reservoir and the canal rehabilitation from Forty Mile Coulee to Sauder Reservoir are completed and operating or through the development of an operational engineering water balance model.

If either approach can establish the operational need for Sauder Reservoir it should be constructed following these guidelines:
a. to provide the minimum storage necessary to improve the operation of the system;
b. to design the reservoir to minimize the loss of irrigated land and the impact on local farms; and
c. prepare the designs in full consultation with local farmers. They have many suggestions for minimizing the impact of the enlarged reservoir that should be fully investigated.

59. The Environment Council recommends that if future experience in the St. Mary Project indicates that significant advances towards an overall 60 per cent irrigation efficiency level are achieved that expansion of Chin Coulee Reservoir by 140,000 acre feet should proceed, the exact timing to be based on the demand for additional irrigated acreage.

60. Reconstruction and enlargement of the St. Mary Main Canal from Milk River Ridge Reservoir to Forty Mile Coulee is recommended with the increase in size related to a future enlarged Chin Coulee Reservoir.

14.8 IRRIGATION EXPANSION NORTH OF THE OLDMAN RIVER

Expansion north of the Oldman River runs out of suitable economically irrigable acreage before available water is fully utilized. The Environment Council estimates that a maximum 57,000 additional acres warrant irrigation in the LNID. Combined with existing assessed acreage, this would give a total future acreage of approximately 170,000 assessed acres in the district. The Council does not feel that major expansion beyond this amount is economically feasible for the foreseeable future.

Recommendations

61. The Environment Council does not believe that seepage problems with an enlarged Keho Lake Reservoir will be severe. However, it recommends that, in the detailed engineering design, careful attention be paid to this problem, with remedial works being provided as required. Detailed design should also include the provision of freeboard dikes to prevent flood damage to neighbouring farms and homes. (See Sections 8.2.3 and 8.2.4.)

62. The Lethbridge Northern Irrigation District Main Canal should be reconstructed and enlarged to 1,500 cfs as soon as possible.

63. Keho Lake Reservoir should be enlarged to about 75,000 acre feet capacity. The timing of work should be such that the reconstruction of the LNID Main Canal and completion of enlargement of Keho Lake Reservoir coincide. (See Sections 8.2.2 and 8.2.4.)

64. The Environment Council recommends construction of Mud Lake Reservoir at a capacity of 65,000 acre feet. The multiple functions of Mud Lake for irrigation, as a potential balancing reservoir to reduce fluctuations on Keho Lake and as a contributor to flow regulation on the Oldman River, make it an attractive facility. The environmental and social impacts of the construction of Mud Lake Reservoir are slight. The Council believes that potential seepage problems connected with this site can be avoided or overcome. (See Section 8.4.)

14.9 ONSTREAM STORAGE

Recommendations

65. The Environment Council is convinced that an onstream dam is not required at this time, nor in the foreseeable future. All the suitable and economically irrigable acres north of the Oldman River can be served by offstream facilities.

    At the irrigation acreage levels recommended by the Council, the offstream facilities proposed should provide for minimum stream flow criteria of 360 cfs measured at Lethbridge, and of 30 cfs on the Waterton, Belly, and St. Mary Rivers (see Recommendation 18). Apportionment should also be satisfied, assuming that 75 per cent of the normal flow of the Red Deer River and 50 per cent of the Bow River is available. (See Section 4.3.1.2.)

66. Although the Management Committee rated the Fort Macleod Dam as the least acceptable of the three onstream dam sites, the Environment Council does not agree with this assessment. Late engineering information indicates that 330,000 acre feet storage could be provided at Fort Macleod at a per acre foot storage cost equivalent to that at Three Rivers. Freeboard dikes at the western end of the reservoir would provide protection to the eastern end of the Town of Fort Macleod.

The least preferable onstream site in the Council's view is the Three Rivers site. Since the environmental and social impacts are much greater than at either Brocket or Fort Macleod, and the Council is unable to find any appreciable engineering or cost advantage for the Three Rivers site, the Council recommends that, should a dam become feasible, only the Brocket and Fort Macleod sites be considered (see Section 9).

67. An onstream dam at Fort Macleod would be required in the event of an inability on the part of the province to conclude satisfactory negotiations with the Peigan Band on either the site of the weir or access to it. Should circumstances require construction of a dam at Fort Macleod to serve the LNID, the Environment Council recommends that Mud Lake Reservoir not be constructed and that the LNID Main Canal only be enlarged to 1,000 cfs to the east of the pump outfall on the main canal (see Section 9.3).

14.10 BENEFIT/COST ANALYSIS

14.11 COMPENSATION

The forcible taking of property is an undesirable act in a free society. The Environment Council shares the public's dislike for this action, but realizes that it must be done in certain circumstances.

Recommendations

68. The Environment Council of Alberta should sponsor an international conference on "Compensating the Unwilling Seller." The problem of compensation for expropriated land is common throughout the free world. Alternative approaches, successes, and failures, from which Alberta could learn, may have been experienced by other jurisdictions in Canada, other Commonwealth countries, and the United States.

69. The Environment Council recommends that expropriation should be avoided if at all possible, but when it cannot be avoided, the case for the taking of property should be established beyond all reasonable doubt. The Council also recommends the following guidelines:
    a. The fewer people disturbed the better. A more costly, less effective facility is to be preferred, if it disturbs fewer people.
    b. The Council urges the Land Assembly Division of Alberta Environment to err on the side of generosity when acquiring land from unwilling sellers.

14.12 INDIAN RESERVES

Indian people are major land holders in the Oldman River Basin and have been much affected by the development of irrigation in the past, and will be affected in the future.

Recommendations

70. The Blood Indians seem to have a viable, well-thought-out plan for the development of irrigation agriculture on their Reserve. They are urged to form an irrigation district. They should then be eligible for all benefits available to irrigation districts. If there is a legal impediment to the Blood Indians becoming an irrigation district, a substantially equivalent status should be achieved by direct contracts and agreements between the province and the Band.

71. The Peigan Band do not have the irrigable land or the physical and economic availability of water to benefit from large-scale irrigation development. Irrigation on the scale of a few hundred acres served by pumping directly from the river or other water bodies for market and vegetable gardens makes sense.

    The major potential benefits to the Peigans from irrigation are the settlements that they might obtain from the sale or lease of the Brocket dam site or the weir site and access to it.

72. The Environment Council recommends a partnership be established between a sensitive Alberta government and the Peigan peoples to search out economic opportunities in agriculture, both dryland and irrigated, and in other potentially economic enterprises. A third member of this partnership might be local experienced farm people, who might be willing to provide advice and counsel to individual Peigans who wish to develop a farming enterprise.

14.13 RESEARCH AND EXTENSION

Recommendations

73. The Environment Council has been impressed with the quality of basic research work carried on in the basin by the federal and provincial governments. The Council urges that the high levels of excellence be maintained. Most of the proposals of the Council in this field have been covered under Recommendation 51, but care should be taken to keep the "Efficiency Fund" in a supplementary role and not as a substitute for continuing support to basic research as presently provided by the federal and provincial governments.

74. To provide permanence to the research facility at Bow Island, which is the centre of rapidly expanding production of specialty crops and has special problems associated with its substantial potential, the site now being leased, or a suitable alternate site, should be purchased.

The Council wishes respectfully, to place these recommendations before you.

Environment Council of Alberta
Panel on
The Management of Water Resources within the Oldman River Basin

AW Platt

A. W. Platt, Chairman

A. D. Crerar, Vice-Chairman

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15. GLOSSARY

15.1 GLOSSARY

This is not a technical glossary, but is intended to assist readers in understanding the report. Detailed definitions of the following terms may be found in scientific works.

Accounting Period With respect to the Master Agreement on Apportionment between Canada, Saskatchewan, and Manitoba, the period over which water withdrawals are considered in order to determine compliance.

Acre Foot The volume of water needed to cover one acre to a depth of one foot (43,560 cubic feet); used for measuring irrigation water, runoff volume, and reservoir capacity.

Aeration of Water Exposing water to air thereby causing reoxygenation. This can be accomplished by natural processes or through mechanical means by spraying, stirring, or other agitation.

Algae Aquatic plants existing either as gelatinous irregular spheres or as cotton-like masses of very fine threads. Depending on the species, they can be attached to stones or larger plants or are found free-floating. Nutrient build-up in water fertilizes algae which can grow and impede the flow of water through water treatment plants, irrigation pumps, and canal systems. When the algae die, their decay can cause BOD problems.

Aquifer A subsurface zone containing groundwater.

Balancing Reservoir A small reservoir used to maintain supply levels in canal systems.

Biochemical Oxygen Demand (BOD) The amount of dissolved oxygen required to meet the metabolic needs of microscopic organisms (bacteria, viruses, yeasts, etc.,) and other decay processes in water containing organic material, such as sewage.

Carrying Capacity The maximum number of individuals of a species that can be supported within a defined physical space over a stated period of time.

cfs Cubic feet per second; a unit of volume flow rate equal to a flow of one cubic foot in one second. One-hundred cfs flowing for one day (24 hours) is approximately equivalent to a volume of 200 acre feet.

CIMMYT The Centro Internacional de Mejoramiento de Maiz y Trigo is an international institute for maize and wheat improvement, with its headquarters in Mexico.

Clearcut A logging system whereby the crop is cleared over a large area at one time. Regeneration of the forest is required in Alberta within 10 years of clearcutting.

Coliform Bacteria Bacteria which are related to intestinal bacteria.

Colluvium-Bedrock Interface The surface where the loose deposits meet the underlying rock.

Cultivar A cultivated variety or species of organism for which there is no known single wild ancestor.

Discount Rate In a benefit/cost analysis, a discount rate allows for the different times when costs are incurred and benefits received, thereby bringing the benefits and costs to a common base.

Dissolved Oxygen (DO) It is essential for the life of fish and other aquatic organisms, including submerged aquatic plants, the combination of high water temperature and lowered dissolved oxygen levels may result in substantial fish kills. During the summer, low stream flows can result in high water temperatures. These high temperatures can be lethal to some species of fish and at the same time, less oxygen can be dissolved in the warmer water. Maintenance of adequate summer streamflows are important, therefore, in assuring livable temperatures for fish and ensuring sufficient oxygen is available for their use.

Drawdown The change in water surface level in a well, reservoir, or natural body of water caused by withdrawal of water.

Drop Structure A concrete, steel, or wooden structure acting as a spillway to control a drop in water level in a canal.

E. Coli *Escherichia coli,* normal intestinal bacteria used as an indication of the amount of raw sewage or animal waste contained in a body of water.

Efficiency

Delivery Efficiency (Ec) The volume of water delivered at the farm headgate as a percentage of the volume of water delivered to the conveyance system at the supply source (S).

Farm Efficiency (Ea) The volume of irrigation water transpired by plants, plus that evaporated from the soil, plus that necessary to maintain the favourable salt content in the soil solution as the percentage of the volume delivered at the farm.

Reservoir Storage Efficiency (Es) The volume of water delivered from the reservoir to the delivery system as a percentage of the volume of water diverted from the streamflow to the storage reservoir.

Irrigation Efficiency (Ei) The mathematical product of the above three efficiencies. Therefore, Ei = Es x Ec x Ea (expressed as a percentage).

Expansion See Appendix 4.

Extension See Appendix 4.

Extension Services Assistance offered to local farmers in the form of education, information, or other advice.

Evapotranspiration Discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces, and by transpiration from plants.

Failure Criteria Criteria, in this case, established by the Oldman River Basin Study Management Committee for irrigation water shortages which could be endured without experiencing a serious reduction in crop yield or farm income.

Freeboard Dike A dike along the edge of a reservoir to contain the water within the reservoir when the level is at or near the full supply level.

Freight Rates
Statutory Rates fixed by government.
Compensatory Rates that are negotiated between the carrier and the shipper.

Freshet A sudden rise in the level of a stream or a flood due to heavy rains or the rapid melting of snow or ice.

Full Supply Level (FSL) The maximum level to which a reservoir is designed to be filled.

Glacial Spillway Channel The ancient riverbed or channel formed by meltwater from prehistoric glaciers.

Green Area An area of Alberta public lands established by statute for resource management purposes.

Groundwater All subsurface water.

Groundwater Discharge Water released from the zone of saturation.

Half Life Time required for one half of a given material to undergo chemical reactions.

Head The height of a column of fluid above a given point considered as a measurement of pressure, usually in feet of water.

Headgate An adjustable gate for controlling the flow of water from a reservoir or main canal system.

Head Loss The loss of head pressure due to a drop in fluid level or friction from flow in a pipe or canal.

Headwaters The source and upstream waters of a stream.

Heat Unit Any of a number of units for quantifying the progress of plant growth in terms of temperature, comprising an elapsed time component, usually expressed in days, and a temperature component reflecting specific crop requirements, and usually related to certain threshold minima and sometimes maxima.

Intensification See Appendix 4.

Lacustrine Deposits Sedimentary deposits belonging to or produced by lakes.

Live Storage That portion of the storage capacity of a reservoir which can be released by gravity flow.

Lowline Proposal Existing main canal system for the St. Mary Project.

Mercurial Fungicide An agent which contains mercury which acts to destroy fungi.

Minimun Flow Criteria The river discharge below which flows should not be allowed to fall. Under conditions outlined in the report, flows would substantially exceed those criteria most of the time.

Nematodes The roundworms, many of which are parasitic to plants and animals.

Net Depletion Total withdrawals minus the water returned directly to the watercourse.

Non-assured Flows Flows in excess of those which can be guaranteed throughout the irrigation season every year. Non-assured flows would be available only at certain times of the year, in very wet years or during a number of consecutive wet years.

Non-point Source of Pollution A pollutant loading that cannot be assigned to a fixed point (for example, runoff from land).

Nutrients in Water Nitrogen and phosphorous compounds. These can be removed through tertiary treatment or through utilization as fertilizer by spray irrigation.

Off-peak Power Power available from a utility when there is a surplus available for purchase at a reduced rate.

Offstream Storage A reservoir which is not located on a major river.

Onstream Storage A reservoir located on its supply stream or river.

Onstream Users See Private Irrigators.

Osmotic Gradient The applied pressure required to prevent passage of a solvent across a membrane which separates solutions of different concentrations, and allows passage of the solute, but may also allow limited passage of the solvent.

Ozone A form of oxygen having three atoms of oxygen rather than the normal two atoms of the conventional form of oxygen gas. A powerful oxidizing agent used for bleaching, sterilizing water, and treating industrial waste.

Point Source of Pollution A pollution source which occurs at a well-defined spot, such as a sewage outfall.

ppm (mg/l) Parts per million (milligrams per litre), in weight per volume used to express the volume or weight of matter in water.

Private Irrigator An individual irrigating directly out of a stream, river, or other water body instead of the irrigation works of a district. An individual pumps at a direct cost
to himself but does not pay a water rate or a water right.

Pulse Crops Examples are peas, beans, and lentils.

Riparian Groundwater Groundwater discharging to a river.

Root Zone Ece The electrical conductivity of soil in the plant root zone. The greater the conductivity, the more saline the soil.

Scheduling An administrative technique for matching water deliveries with crop water needs.

Seasonal Water Use Multiple Regression Equation Statistical technique used to correlate rainfall records with the water use by an irrigation project measured at the diversion point. A prediction can then be made regarding the amount of water required for irrigation in future years.

Sewage Lagoon A body of water constructed and maintained to store and treat waste.

Sewage Treatment

Primary Solids in water are removed by mechanical means such as settling tanks or screening.

Secondary Biological treatment of waste water, following primary treatment, to remove finely divided, suspended, and dissolved materials remaining in the wastewater after primary treatment, and to reduce the BOD.

Tertiary Following conventional secondary treatment methods, various types of additional techniques can be employed to remove nutrients remaining in the waste water (primarily phosphates and nitrates).

Industrial Pretreatment The method will vary depending on the waste material produced, but refers to preliminary treatment by industry before placing waste water into municipal sewage systems.

Silage Green or mature fodder that is fermented to retard spoilage and produce a succulent feed for livestock.

Siphon A tube, pipe, or hose through which a liquid can be moved from a higher to a lower level by atmospheric pressure forcing it up the shorter leg, while the weight of the liquid in the longer leg causes continuous downward flow.

Slash The residue left on the ground after forestry operations. It includes unutilized logs, uprooted stumps, broken or uprooted stems and the heavier branchwood, lighter tops and branchwoods, twigs, leaves, bark and chips.

Sludge A liquid waste with a solid concentration in excess of 2,500 parts per million, obtained during the treatment of municipal sewage.

Slumping A type of landslide characterized by the downward slipping of a mass of unconsolidated debris.

Sorghum Any of a variety of widely cultivated grasses grown for grain and forage. They require a relatively long growing season and high temperatures.

Spillway A passage in or near a dam or other hydraulic structure for escape of water, thereby protecting the structure from washout.

Spray Irrigation of Wastewater Concept of using partially treated municipal or industrial wastewater for spray irrigation. Wastewater is generally partially treated; municipal wastes usually treated to the secondary level by lagooning.

Storage Capacity The volume of water which can be stored in a reservoir.

Storage Reservoir A reservoir with outlets controlled by gates that release surface water as needed. Also known as an impounding reservoir.

Sulphurcrete An experimental sulphur-concrete material used in construction.

Suspended Solids A mixture of fine particles of any solid suspended, but not dissolved, in water.

Terminable Agreement The board of an irrigation district can enter into an agreement with a landowner to provide water on the understanding that it can be terminated with appropriate notice (as defined by the Irrigation Act) by either party. Rates charged vary.

Transpiration The loss of water vapour from plants.

Water Balance Model Generally, a computer program of an area which incorporates data on stream flows, existing storage, water withdrawals, and other demands on the water supply (apportionment, fishery requirements, recreation). By altering the various factors, the model can be used to predict the effect on the basin of any changes in water supply or demand.

Water Table The depth below which the ground is saturated with water.

16. REFERENCES

16.1 REFERENCES

Acres Consulting Services Limited. 1978. *Oldman River Basin Phase II Study: Water Balance Model.* Edmonton: Oldman River Study Management Committee.

Agriculture Canada. 1974. *Canada Animal Waste Management Guide.* Ottawa: Department of Agriculture.

Alberta Agriculture. May 1978a. *Oldman River Flow Regulation Studies, Phase II: Irrigation Studies, Expansion Priorities.* Edmonton: Alberta Agriculture, Irrigation Division, Project Planning Branch.

Alberta Agriculture. 1978b, *1977/78 Annual Report.* Edmonton: Alberta Agriculture.

Alberta Agriculture. 1977. *Peigan Indian Reserve, Preliminary Engineering Report on the Feasibility of Peigan Project.* Lethbridge: Alberta Agriculture, Irrigation Division, Planning Section.

Alberta Agriculture. 1975. *Preliminary Irrigation Study and Development Proposals for Irrigation Districts.* Lethbridge: Alberta Agriculture, Irrigation Division.

Alberta Energy and Natural Resources. 1977. *A Policy for Resources Management of the Eastern Slopes.* Edmonton: Alberta Energy and Natural Resources.

Alberta Environment. 1978a. *Wastewater Utilization in the Oldman River Basin.* Edmonton Oldman River Study Management Committee.

Alberta Environment. 1978b. *Guidelines for Control of Industrial Wastes Discharging to Municipal Sewerage Systems.* Edmonton: Alberta Environment.

Alberta Environment. 1977a. *Report on a Review of Alberta Environment's Position on the Repair of Bassano Dam.* Edmonton: Alberta Environment, Planning Division, Southern Region.

Alberta Environment. 1977b. *Level 1 Engineering Report on the LNID Headworks and Main Canal Expansion and Rehabilitation (Addendum) Keho Lake Storage Expansion.* Edmonton: Alberta Environment. Environmental Engineering Support Services, Design and Construction Division.

Alberta Environment. 1976. *Oldman River Flow Regulation Preliminary Planning Studies* 5 Volumes. Edmonton: Alberta Environment, Planning Division.

Alberta Environment. 1975. *Red Deer River Flow Regulation Planning Studies.* 7 Vols., Edmonton: Alberta Environment, Planning Division.

Alberta Environment. 1972a. *Alberta Livestock Operations Waste Management Survey,* Computer Print-out, Edmonton: Alberta Environment.

Alberta Environment. 1972b. Position Paper No. 5—Financial Assistance for Water Management. Edmonton: Alberta Environment.

Alberta Environment and Alberta Agriculture. 1973. *Confinement Livestock Facilities Waste Management: Code of Practice.* Edmonton: Alberta Environment and Alberta Agriculture.

Anderson, Marv and Associates Limited. 1979. *Price-Quantity Relationships for Irrigation Water in Southern Alberta.* Edmonton: Environment Council of Alberta.

Anderson, Marv & Associates Limited. 1978. *Oldman River Basin Study Phase II: Economic Analysis of Water Supply Alternatives.* Edmonton: Oldman River Basin Study Management Committee.

Blakeslee, L. L., Heady, E. O., and Framingham, C. F. 1973. World Food Production, Demand and Trade. Iowa State University Press.

Boothroyd, Peter and Co-West Associates. 1978. *Oldman River Basin Study Phase II: Social Impact Assessment.* Edmonton: Oldman River Basin Study Management Committee.

Deinzer, M., Schaumburg, F., Klein, E. 1978 "Environmental Health Sciences Centre Task Force Review on Halogenoted Organics in Drinking Water." *Environmental Health Perspectives.* v. 24, pp. 209-239.

Dempsey, H. A. 1978. *Indian Tribes of Alberta.* Calgary: Glenbow-Alberta Institute.

Energy Resources Conservation Board. 1978. *Oldman River Basin Phase II Studies: Hydroelectric Energy Potential.* Edmonton: Oldman River Basin Study Management Committee.

Envirocon Limited. n.d. *Oldman River Basin Study Phase II: Water Quality.* Edmonton: Oldman River Basin Study Management Committee.

Environment Canada. 1978. *Surface Water Data: Alberta, 1977.* Ottawa: Environment Canada, Inland Water Directorate, Water Resources Branch.

Environment Council of Alberta. 1979. *The Environmental Effects of Forestry Operations in Alberta: Report and Recommendations.* Edmonton: Environment Council of Alberta.

Evans, Francis L. (ed.). 1972. *Ozone in Water and Wastewater Treatment.* Ann Arbor, Michigan: Ann Arbor Science Publishers.

Exner, K. K. 1977. *A Report on the Nuisance Growth of Filamentous Algae in the South Saskatchewan River Basin.* Edmonton: Alberta Environment, Pollution Control Division.

Forbis, R. G. 1960. *Some Late Sites in the Oldman River Region.* National Museum of Canada Bulletin No. 162, pp. 119-164. Ottawa: Department of Northern Affairs and Natural Resources.

Glatz, B. A., Chriswell, C. D., and Arguello, M. D., Svec, H. J., Fritz, J. S., Grimm, S. M., Thomson, M. A. 1978. "Examination of Drinking Water for Mutagenic Activity." *Journal of American Water Works Association.* v. 70, pp. 465-468.

Holmgren, Eric J. and Patricia M. 1972. *2,000 Place-Names of Alberta.* Saskatoon, Saskatchewan: Modern Press.

International Joint Commission. 1977. *Annual Report - 1977.* Ottawa: International Joint Commission.

"Irrigated Land Projected," *Irrigation Age,* March 1979. v. 13, No. 6. p. 86.

Johnson, R. V. 1977. *Phosphorous Removal at the City of Calgary Bonnybrook Sewage Treatment Plant.* Calgary: University of Calgary, Department of Civil Engineering.

Karkanis, P. G. 1975. *Red Deer River Basin Preliminary Irrigability Report.* Edmonton: Alberta Department of Agriculture, Irrigation Division, Technical Resources Branch, Irrigation Soils Section.

Kitchen, H. M. 1975. *A Statistical Estimation of a Demand Function for Residential Water.* Canada, Department of the Environment, Inland Waters Directorate, Water Planning and Management Branch, Ottawa, Canada. Social Science Series No. 11.

Klohn Leonoff Consultants Limited. 1978a. *Phase II Study: Water Supply Alternatives.* Edmonton: Oldman River Basin Study Management Committee.

Klohn Leonoff Consultants Limited. 1978b. *Fort Macleod, Prefeasibility Study.* Edmonton: Oldman River Study Management Committee.

LGL Limited and the Sibbald Group. 1978. *Environmental Inventory Report, Oldman River Basin.* Edmonton: Oldman River Basin Study Management Committee.

Lombard North Group and the Sibbald Group. 1978. *Overview of: Selected On Stream and Off Stream Storage Sites in the Oldman River Basin.* 2 Vols. Edmonton: Oldman River Basin Study Management Committee.

Loper, J. C., Lang, D. R., Sheeny, R. S., Richmond, B. B., Gallagher, M., Smith, C. C., 1978. "The Residue Organic Mixture from Drinking Water Show *In Vitro* Mutagenic and Transforming Activity." *Journal of Toxicology and Environmental Health.* v. 4, pp. 919-938.

McCracken, L. J. 1970. *Irrigation Project Rehabilitation in Alberta.* Lethbridge: Department of Agriculture. Presented at Canadian Society of Agricultural Engineers Conference, Ottawa, July 7.

McKenzie, C. R. 1978. *Soil Salinity Affects the Field of Corn in Southern Alberta.* Alberta Department of Agriculture, Agriculture Communications, Agriculture News, November.

Meat Industry Research Services Ltd. 1979. *The Economic Viability of Increased Beef Feeding in Alberta.* Edmonton: Environment Council of Alberta.

Meek, U., Spence, G., and Hunter, W. E., 1942. *Report on Further Storage and Irrigation Works Required to Utilize Fully Canada's Share of International Streams in Southern Alberta. St. Mary and Milk Rivers.* Ottawa: Water Development Committee.

Muller, Gertrud and Niemitz, Walters. 1978. "Epidemiological Considerations to Drinking Water and Sewage Disinfection." In *Water Development and Management. Proceedings of the United Nations Water Conference, Mar Del Plata, Argentina, March 1977. Part 4,* p. 2277. (Water Development, Supply, and Management, v. I.) Oxford: Pergaman Press.

Nielsen, G. L. 1971. *Hydrogeology of the Irrigation Study Basin, Oldman River Drainage, Alberta, Canada.* Brigham Young University Geology Studies.

Northwest Hydraulic Consultants Limited. 1978a. *Reservoir Sedimentation and River Degradation.* Edmonton: Oldman River Basin Study Management Committee.

Northwest Hydraulic Consultants Limited. 1978b. *Reservoir Sedimentation and River Degradation: Supplementary Field Reconnaissance Report.* Edmonton: Oldman River Basin Study Management Committee.

Northwest Hydraulic Consultants Limited. 1977. *Watershed Management for Increased Water Yield.* Edmonton: Oldman River Basin Study Management Committee.

Oldman River Study Management Committee. 1978. *Oldman River Basin—Phase II Studies: Report and Recommendations. Oldman River Final Report.* Edmonton: Oldman River Study Management Committee.

Prengle, William H. and Mauk, Charles E. 1978. "New Technology: Ozone/UV Chemical Oxidation Wastewater Process for Metal Complexes, Organic Species and Disinfection." In *Water 1977,* pp. 228-244. (AIChE Symposium Series No. 178, v. 74.) Edited by Gary F. Bennett. New York: American Institute of Chemical Engineers.

St. Mary River Irrigation District. 1978. *Irrigation Efficiency on the St. Mary Project.* Presented to the Oldman River Basin Study Management Committee in Medicine Hat. February 15, 1978.

Stanley/SLN Consulting Limited. 1978. *Irrigation Studies: Efficiencies, Seepage and Salinization Expansion Priorities.* 2 Vols. Edmonton: Oldman River Basin Study Management Committee.

Underwood McLellan (1977) Limited. 1978a. *Oldman River Basin Phase II Water Use Study: Water Oriented Recreation.* Edmonton: Oldman River Basin Study Management Committee.

Underwood McLellan (1977) Limited. 1978b. *Groundwater in the Oldman River Basin.* Edmonton: Oldman River Basin Study Management Committee

Underwood McLellan (1977) Limited. 1978c. *Water Use in the Oldman River Basin.* Edmonton: Oldman River Basin Study Management Committee.

Underwood McLellan (1977) Limited. 1978d. *Report on a Comparison of Highline and Lowline Development: St. Mary Irrigation Project.* Edmonton: Underwood McLellan.

Underwood, McLellan and Associates Limited. 1977. *Main Report, Main Canal Planning Study. St. Mary River Irrigation Project.* Prepared for St. Mary River Irrigation District.

Vander Pluym H. S. A. 1978. "Extent, Causes and Control of Dryland Saline Seepage in the Northern Great Plains Region of North America." In *Dryland-Saline-Seep Control.* Proceedings Meeting of the Subcommission on Salt-Affected Soils at the 11th International Soil Science Society Congress, Edmonton. June 1978. Edmonton: Alberta Agriculture.

Water Resources Council. *Water and Related Land Resources: Establishment of Principles and Standards for Planning.* Federal Register, v. 38, No. 74.

Wilson, D. B. and Slen, S. B. 1974. *Irrigated Pastures for Cattle in Western Canada.* Publication No. 1526. Ottawa: Department of Agriculture.

Yocum, Floyd. H., Mayes, James H., and Myers, William A. 1978. "Pretreatment of Industrial Wastes with Ozone." In *Water 1977,* pp. 217-227. (AIChE Symposium Series No. 178, v. 74.) Edited by Gary F. Bennett. New York: American Institute of Chemical Engineers.

17. APPENDICES

17.1 APPENDIX 1: CONSULTANTS REPORTS

Acres Consulting Services Limited. April 1978. *Oldman River Basin Phase II Study: Water Balance Model.* Edmonton: Oldman River Study Management Committee.

Alberta Environment. April 1978. *Wastewater Utilization in the Oldman River Basin.* Edmonton: Oldman River Study Management Committee.

Anderson, Marv & Associates Limited. April 1978. *Oldman River Basin Study Phase II: Economic Analysis of Water Supply Alternatives.* Edmonton: Oldman River Basin Study Management Committee.

Boothroyd, Peter and Co-West Associates. July 1978. *Oldman River Basin Study Phase II: Social Impact Assessment.* Edmonton: Oldman River Basin Study Management Committee.

Energy Resources Conservation Board. ERCB. June 1978. *Oldman River Basin Phase II Studies: Hydroelectric Energy Potential.* Edmonton: Oldman River Basin Study Management Committee.

Envirocon Limited. n.d. *Oldman River Basin Study Phase II: Water Quality.* Edmonton: Oldman River Basin Study Management Committee.

Klohn Leonoff Consultants Limited. May 1978. *Phase II Study: Water Supply Alternatives.* Edmonton: Oldman River Basin Study Management Committee.

LGL Limited and the Sibbald Group. January 1978. *Environmental Inventory Report, Oldman River Basin.* Edmonton: Oldman River Basin Study Management Committee.

Lombard North Group and the Sibbald Group. July 1978. *Environmental Overview of: Selected On Stream and Off Stream Storage Sites in the Oldman River Basin.* 2 Vols. Edmonton: Oldman River Basin Study Management Committee.

Northwest Hydraulic Consultants Limited. March 1978. *Reservoir Sedimentation and River Degradation.* Edmonton: Oldman River Basin Study Management Committee.

Northwest Hydraulic Consultants Limited. June 1978. *Reservoir Sedimentation and River Degradation: Supplementary Field Reconnaissance Report.* Edmonton: Oldman River Basin Study Management Committee.

Northwest Hydraulic Consultants Limited. December 1977. *Watershed Management for Increased Water Yield.* Edmonton: Oldman River Basin Study Management Committee.

Stanley/SLN Consulting Limited. April 1978. *Irrigation Studies: Efficiencies, Seepage and Salinization Expansion Priorities.* 2 Vols. Edmonton: Oldman River Basin Study Management Committee.

Underwood McLellan (1977) Limited. April 1978. *Groundwater in the Oldman River Basin.* Edmonton: Oldman River Basin Study Management Committee.

Underwood McLellan (1977) Limited. March 1978. *Oldman River Basin Phase II Water Use Study: Water Oriented Recreation.* Edmonton: Oldman River Basin Study Management Committee.

Underwood McLellan (1977) Limited. April 1978. *Water Use in the Oldman River Basin.* Edmonton: Oldman River Basin Study Management Committee.

17.2 APPENDIX 2: DISTRIBUTION OF PROCEEDINGS

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Grande Prairie, Alberta
T8V 0V3

The Library
Roland Michener High School
Box 788
Slave Lake, Alberta
T0G 2A0

Edmonton Public Library
Government Information Division
7 Winston Churchill Square
Edmonton, Alberta
T5J 2V4

Alberta Environment Library
14th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta
T5K 2J6

Calgary Public Library
Business and Science Division
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Calgary, Alberta
T2G 2M2

Red Deer Public Library
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Red Deer, Alberta
T4N 1T8

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Lethbridge, Alberta
T1J 4C4

Drumheller Public Library
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Medicine Hat, Alberta
T1A 0A8

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17.3 APPENDIX 3:

BRIEFS PRESENTED TO THE OLDMAN RIVER PUBLIC HEARINGS

Lethbridge - November 6, 7, 1978

	Name	Representing
1.	Fraser, Alan	Unifarm
2.	Fauser, Horst	Alberta Fish and Game Association
3.	Fraser, Alan	Personal
4.	Veeman, Terry	Personal
5.	Nemeth, Frank	Personal
6.	Bailey, Mary	Federation of Alberta Naturalists
7.	Dormaar, John	Archaeological Society of Alberta
8.	Briscoe, Earl	County of Lethbridge No. 26
9.	White, Bob	Alberta Irrigation Projects Association
10.	Daniels, Bob	Alberta Irrigation Projects Association
11.	Scully, Gene	Lethbridge Fish and Game Association
12.	Langman, Peter	Water Users in Coaldale Area
13.	Anderson, A. C. (Mayor)	City of Lethbridge
14.	Bouey, Doug	Blood Indian Band
15.	Hranac, Ed	Personal
16.	Hall, Elizabeth	Personal
17.	Palmer, Asael	Personal
18.	Postman, Tony	Personal
19.	Ross, Frederick	Personal
20.	Collier, G. E., D.V.M.	Personal
21.	Boras, Walter F.	Personal
22.	Wood, Burns	Alberta Suger Beet Growers Association
23.	Rickwood, Roger	Lethbridge East NDP

Fort Macleod - November 9, 1978

24.	Siemens, Frances	Foothills Division of Girl Guides of Canada
25.	Buckwell, Leighton	Lethbridge Northern Irrigation District
26.	Sandberg, Eric	Local Farmers Fort Macleod Site
27.	Sup, Willie	Personal
28.	Bond, Kent	Personal
29.	Smit, Kornelius	Personal
30.	Nauta, Brian A.	Personal
31.	Dea, Colin	Town of Fort Macleod
32.	Zoeteman, Samual	Personal
33.	Sandberg, Eric	Personal
34.	Zoeteman, Robert	Personal
35.	Emmelkamp, Herman	Personal
36.	Brown, George	Fort Macleod Historical Association
37.	MacLeod, John	Personal
38.	Havinga, Jacob	Personal

Picture Butte - November 14, 15, 1978

39.	Konynenbelt, Alan	Personal
40.	Nemeth, Frank	Picture Butte & District Chamber of Commerce
41.	Vander Schaaf, Jake	Christian Farmers' Federation
42.	Zech, Don	Personal
43.	Kovacs, Andrew	Personal
44.	Westrop Family	Personal
45.	Thirnbeck, Roger	Public Advisory Committee of the Environment Council of Alberta
46.	Schuld, Peter	Calgary Milk Producers's Association
47.	Nummi, Henry	Keho Lake Community Club
48.	Loman, Ben	Personal and Lethbridge Northern Irrigation District
49.	Stringam, Enes	Mark Stringam Ranches Limited
50.	Geers, Adrian	Bow River Irrigation District
51.	Bergen-Henen Gouwen, Art	Iron Springs Local of Unifarm
52.	Nieboer, Elroy	District 142 Unifarm
53.	Van Raay, Cor	Personal
54.	Taguchi, Noris	Lethbridge Northern Sugar Beet Growers Association
55.	Beamer, Ross	Personal
56.	Eisenhauer, John	Personal
57.	Hackler, Garry	Personal
58.	Davis, J. R.	Personal
59.	Spencer, Buck	Personal
60.	Spencer, Buck	Keho Park Golf Club
61.	Noble, Cyril	Alberta Irrigation Projects Association
62.	Stroeve, Herman	Personal
63.	Vanden Heyden, John	Personal
64.	Jensen, Roy	Personal
65.	Erdman, Douglas	Concerned Landowners adjacent to Canal
66.	Machacek, Frank	Village of Barons
67.	Ries, Pius	Town of Picture Butte

Taber - November 17, 1978

68.	Columbo, Keith	Big "O" Drain Tile Company Limited
69.	Hummel, Roy	Verdigris Coulee Irrigation Committee
70.	Reese, Hovey	Personal
71.	Cradduck, Mervin	Personal
72.	Francis, Keith	Taber Irrigation District
73.	Anderson, Ken P.	Alberta Irrigation Projects Association
74.	Boyer, Karen	Oldman River Regional Planning Commission
75.	Madge, Frank	Milk River District Chamber of Commerce
76.	Leahy, George	High Line Steering Committee
77.	Dick, Henry	Bow River Gas Co-op
78.	Truyaert, Michael	Personal
79.	Pyne, Mike	Pyne Brothers Farms Limited
80.	Daisley, J. C.	Town of Taber
81.	Gibb, Roscoe	Taber Chamber of Commerce

Pincher Creek - November 20, 1978

82.	Gysi, Dr. Marshall	Science Advisory Committee of the Environment Council of Alberta
83.	Hammond, Scott	For Joseph Glass
84.	Hammond, Scott	Personal
85.	Fauser, Horst	Alberta Fish and Game Association
86.	Allison, Lorraine	For Dr. Ron Wallace
87.	Allison, Lorraine	For Ms. D. Dickinson
88.	Cooper, Mike	Three River Committee
89.	Reeder, Dan	Personal
90.	Dudley, George	Magrath Irrigation District
91.	Yellowhorn Sr., Albert Smith, Percy	Peigan Band
92.	Haney, Harry	Personal
93.	Schultz, Frances	Personal
94.	Imeson, Dale	Personal
95.	Russell, Andy	Personal
96.	Thornton, Doug	Personal
97.	Buhrmann, Dr. Hans	All River Users
98.	Sheppard, Dave	Personal
99.	Pharis, Hilton	Personal
100.	Toney, Bob	Municipal District of Pincher Creek
101.	Gainer, Grant	Personal
102.	Terans, Dr. Juan	Town of Pincher Creek
103.	Van Gelderen, Dirk	Personal
104.	Graham, Norris	Personal
105.	Graham, Madge	Personal
106.	Daeley, John	Personal
107.	Frederick, Bruce	Personal

Cowley - November 21, 1978

108.	Maloff, Pete	Personal
109.	Westrop, Audrey	Personal
110.	Allison, Lorraine	Personal
111.	Ross, Rick	Alberta Irrigation Projects Association
112.	McClelland, Doug	Personal
113.	Robin, Marilyn	Personal
114.	Cooper, Mike	Personal
115.	Day, Bob	Personal
116.	Ross, Rick	Lethbridge Northern Irrigation District
117.	Smyth, Jim	Personal
118.	Thibert, Joe	Group North of the Dam
119.	Smith, Eddie	Personal
120.	Collins, Rhonda	Personal
121.	Hammond, Henry	Personal
122.	Bougerolle, Leonard	Personal
123.	Brockwell, Jim	Personal
124.	Welsch, Reno	Personal
125.	Buchanan, Doug	Personal

126.	Daeley, John	Personal
127.	Day, Kathleen	Personal
128.	Smith, Ted	Willow Valley Trophy Club
129.	Day, Dorothy	Personal
130.	Duke, Jack	Personal
131.	Hodgson, Murray, M. D.	Personal
132.	Irving, Dr. Anthony	Personal
133.	Hall, Reid	Personal
134.	Hall, Virginia	Personal
135.	Day, Lesley	Personal
136.	Wolbert, Walter	Personal
137.	Davis, Ferol	Personal
138.	Glenn, Reid	Personal
139.	Hall, Susan	For Audrey Westrop - Personal
140.	Hackler, Garry	Personal
141.	Elton, William	Personal
142.	Hackler, Cheryl	Town of Cowley Citizens
143.	Michalsky, William	Personal
144.	Eisenhauer, John	Personal
145.	Reners, John	Reners Farms Limited
146.	Smyth, Roy	Cowley Feed and Seed Service Limited
147.	Patterson, Ernie (Mayor)	Town of Claresholm
148.	Patterson, Ernie	Personal
149.	Hackler, Garry	Students of Livingstone High School
150.	Giacchetta, Tony	Personal
151.	Haugen, Marjorie	Town of Cowley

Bow Island - November 28, 1978

152.	Droog, Tom	Personal
153.	Arnold, Vernon	County of Forty Mile No. 8
154.	Lynes, E. S.	Village of Foremost
155.	Klok, Robert	Alberta Vegetable Marketing Board
156.	Chow, Don	Bow Island Recreation Board
157.	Strom, Walter	Town of Bow Island
158.	Hirch, Edmund	Personal
159.	Stampbach, Brian	Town of Bow Island
160.	Crosthwaite, J. C.	Eastern Division St. Mary River Irrigation District
161.	Smith, Bryce	Bow Island and District Chamber of Commerce
162.	Dykstra, Bob	Personal
163.	Thacker, George	Personal
164.	Gravel, Dave	Personal
165.	Butler, Richard	Burdett-Bow Island Sugar Beet Growers Association
166.	Matthews, Gough	Personal
167.	Papworth, R. W.	County of Lethbridge
168.	McKnight, Dean	Southern Alberta Co-op
169.	Buckwell, L. E.	Lethbridge Northern Irrigation District
170.	Nelson, S. A.	Alberta Irrigation Projects Association and Raymond Irrigation District

171.	Prudek, V. C.	Alberta Bean Growers Association
172.	Onischuk, Stefan	Personal
173.	Doherty, Larry	Bow Island Fish and Game Association
174.	Brown, J. E.	Alberta Irrigation Projects Association
175.	Gilbertson, Wayne	Personal
176.	Ailsby, Gerry	Personal

Medicine Hat - November 29, 1978

177.	Sauer, K. C.	City of Medicine Hat
178.	Griffin, Diane	Alberta Society of Professional Biologists
179.	Balston, Roy	Southeast Alberta Regional Planning Commission
180.	Blackwell, S. R.	Government of Saskatchewan Department of the Environment
181.	Lehr, Reinhold	Medicine Hat CHamber of Commerce Irrigation Committee
182.	Lehr, Reinhold	Brooks and District Chamber of Commerce
183.	Chorel, M. J.	Electric Utility Planning Council
184.	Laycock, Dr. A.	Personal
185.	White, Richard	Red Deer Regional Planning Commission
186.	Nott, Gladys	Personal
187.	Babe, James	Land Owners and Operators Sauder Reservoir Area
188.	Olechowski, Perry	Personal
189.	Duffy, Pat	Eastern Irrigation District
190.	Hofer, Rev. John	Hutterian Brethren of Winnifred
191.	Trapp, Norman	N. R. Trapp Farms Limited
192.	Deering, Eugene	Personal
193.	Ross, Rick	Lethbridge Northern Irrigation District
194.	Geers, Adrian	Alberta Irrigation Projects Association
195.	Smith, C. W.	Personal
196.	Zorn, Douglas	Personal
197.	Geers, Adrian	Bow River Irrigation District
198.	Sundstrom, Dr. Marvin	Personal
199.	Brandley, Theodore	Sprinkler Irrigation Equipment Dealers
200.	Brown, Jim	St. Mary River Irrigation District
201.	Hargrave, Bert	Personal
202.	Biemans, Ken	Seven Persons and District Farmers
203.	Shepherd, D. R.	Personal
204.	Beatch, Leonard and Delores	Personal
205.	Hogg, Nelson D.	Personal

Supplementary Briefs

206.	Eisenhauer, John	Personal
207.	Edgar, J. C. (Mayor)	Town of Fort Macleod
208.	Pollock, Sid	Personal
209.	Buhrmann, H. G.	Personal
210.	Allison, Lorraine	Personal
211.	Meulenbeld, Ben	Canadian Hunter Exploration Limited
212.	McKenzie, L.	Personal
213.	Braun, John	Personal
214.	Jericho, K.	Personal
215.	Dickson, A. T.	Calgary Field Naturalists' Society
216.	Columbo, Keith	Big "O" Drain Tile Company Limited
217.	Daley, Wallace	Municipal District of Willow Creek No. 26
218.	Smith, John W.	Peigan Reserve
219.	Banks, Irene	Personal
220.	Brandley, Theodore	Oliver Industrial Supply Limited
221.	Westrop, Audrey	Personal
222.	Hardy, R. F.	Personal
223.	Burles, Mary Jo	Personal
224.	Hofer, Rev. John	Hutterian Brethren of Winnifred
225.	Schutz, Fred	Red Deer River Naturalists
226.	Imeson, Dale J.	Personal
227.	Andersen, Paul C.	Personal
228.	Nott, Bruce and Gladys	Personal
229.	Smerek, Philip	Personal
230.	Krizan, Mary A.	Personal
231.	Willms, David	Personal
232.	Deering, Eugene and Ann	Personal
233.	Evanson, John E.	Personal
234.	Langeman, Peter	Personal
235.	Davidson, Peter	Personal
236.	Ellison, R. W.	Personal
237.	McIvor, Mike	Federation of Alberta Naturalists
238.	Barrows, Lloyd	Personal

17.4 APPENDIX 4: POTENTIAL FOR INCREASING IRRIGATION ACREAGE

Two factors affect estimates of potential increases in irrigation acreage; definition of terms, and lack of precise knowledge.

1. Definition of Terms

Increasing irrigation acreage is commonly referred to in three stages; intensification, extension, and expansion. Stanley/SLN (1978) and the Management Committee defined the terms as follows:

Intensification enlargement of the irrigated acreage within the irrigation district without expenditures for district works beyond provision of new irrigation gates.

Extension enlargement of the irrigated acreage within districts by providing new minor ditches plus irrigation gates, for example, ditches of one or two miles plus irrigation gates to serve new areas of up to approximately 1,000 acres.

Expansion enlargement of the irrigated acreage outside the districts by providing projects works to serve new areas in excess of 1,000 acres.

These definitions, according to Stanley/SLN, were agreed to by the LNID, SMRID, TID, and RID.

Alberta Agriculture, Irrigation Division (1978a) defines the terms as follows:

Intensification the development of additional irrigable acreage on parcels already having delivery within the irrigation districts. Costing estimates include up to 1/2 miles of feeder canal.

Extension additional irrigable acreage adjacent to the existing irrigation systems within the boundaries of the irrigation districts. Cost estimates include discussion of small blocks of 10,000 acres or under and larger blocks of 20,000 acres or more. Development of 29,700 acres in the Albion Ridge block is included as an extension.

Expansion the development of new irrigable acreage outside of the irrigation districts. Expansion differs from extension in that, main canal, distribution works and, possibly, reservoir works are required to be constructed to serve these areas.

Underwood McLellan (1977) simplified the process for the St. Mary Project by estimating the irrigable acreage within one mile of the existing system and, blocks within the SMRID which could be served by a system of greater than one mile in length.

2. Knowledge

No detailed analysis has been done of how much irrigable land is available. Acreages are based on "preliminary classification", "office studies," or "experience."

In the following tables, the Environment Council has presented the information available to them. Explanatory footnotes are included, however, the reader may become confused upon investigating further. In the body of the report the following ranges, taken from these tables, have been used to provide an indication of the acreage that can be developed economically. Even this must be qualified, since some "expansion" areas have economic or other advantages and should be given priority. Aetna, Leavitt, Magrath, Raymond, United Irrigation Districts—do not have increases in acreage.

LNID - 28,500 to 57,000 acres
SMRID - 87,250 to 184,500 acres
TID - 13,500 to 23,000 acres

Table A

Acreage Available for Intensification

Aetna	0[1]	-	3,500[3]	(3,506)[4-a]
Leavitt	0[1]	-	1,000[3]	970[4]
LNID	20,000[1]	40,000[2]	34,000[3]	28,264[4-b]
Magrath	0[1]	4,000[2]	1,200[3]	2,220[4]
Mountain View	0[1]	-	0[3]	0[4]
Raymond	0[1]	-	0[3]	0[4-c]
SMRID	80,000[1]	161,500[2]	34,600[3]	15,449[4]
Taber	12,000[1]	23,500[2]	16,200[3]	4,451[4]
United	0[1]	-	0[3]	-

1. Stanley/SLN 1978. Acreage estimated on the basis of soil classification for the irrigation district without determining the percentage of each soil class presently irrigated *versus* the percentage still in dryland.

2. District board estimates, March 1978, as given in Stanley/SLN. Acres given for the SMRID, MID, and TID are from Underwood McLellan (1977) and based on a different definition than used by Stanley/SLN.

3. Alberta Agriculture 1978a. Potential acreages were obtained from "Preliminary Irrigation Study Development Proposals" (see footnote 4) and "adjusted to reflect the 1977 increased assessment."

4. Alberta Agriculture 1975. Estimated acreage increased to 1985. No distinction made between intensification and extension. Values have been adjusted to reflect 1977 increased assessment.

   a. Involves "new system and main canal extensions" costing $332,900 (1975).
   b. Cannot separate intensification and extension acreages, however, within the ten-year program considerable canal enlargement and new canal construction is projected.
   c. 1977 assessed acreage exceeds the report projections. Acreage increased from 23,257 in 1974 to 30,775 in 1977.

Table B

Acreage Available through Extension

Aetna				
Leavitt				
LNID	8,500[1]	17,000[2-a]	29,700[3-a]	-[4-a]
Magrath	0[1]	15,000[2]		
Mountain View				
Raymond				
SMRID	11,500[1]	23,000[2]	52,650[3-b]	-[4-b]
Taber	2,000[1]		4,000[3-c]	-[4-c]
United				

1. Stanley/SLN 1978.

2. District board estimates, March 1978. As given in Stanley/SLN, Information for Magrath and SMRID from Underwood McLellan (1977). LNID figures estimates include only 2 to 4,000 acres in Albion Ridge block (Personal communication - R. Ross).

3. Alberta Agriculture 1978a. Potential acreages were identified from "Preliminary Irrigation Study Development Proposals" (see footnote 4).
   a. Acreage available in Albion Ridge block.
   b. Extensions adjacent to the SMRID; Lethbridge-Coaldale South, North Lethbridge, Yellow Lake South, N. W. Burdett, N. W. Sauder.
   c. Extension adjacent to the TID; Horsefly North.

4. See previous table, footnote 4.

Table C

Acreage Available within the St. Mary Project

	Within 1 Mile of Existing System	More than 1 Mile Beyond System	Modified by Irrigation Division
SMRID	161,500[1]	23,000	121,500[2]
TID	23,500[1]		13,500[2]
MID	4,000[1]	15,000	15,000[2]
RID	0		

1. Underwood McLellan (1977) obtained their information from Alberta Agriculture, Irrigation Division and modified it to include a one mile strip above the SMRID Main Canal.

2. Alberta Agriculture 1978a. Reassessment of the Underwood McLellan report to provide recommended levels of development as opposed to potential. New figures based on "estimated costs, water supply, land quality, physical feasibility, historical development, and viability of existing projects, applying the best judgement and experience of the staff."

17.5 APPENDIX 5

IRRIGATION EXPANSION UNITS AND PRIORITIES PROPOSED BY THE IRRIGATION DIVISION

Project Name	New Acres	Priority Rating
Chin East	43,000	1
North Lethbridge	3,750	2
Horsefly North	4,000	3
Lethbridge Coaldale South	25,000	4
North West Sauder	6,700	5
West Forty Mile	90,000	6
Yellow Lake South	10,500	7
North West Burdett	6,700	8
Skiff	60,000	9
East Forty Mile	17,000	10
Raymond South East	18,000	11
Raymond East	15,000	12
New Dayton	50,000	13
South Keho	12,000	14
North Magrath	10,000	15
Blood Indian Reserve	50,000	16
Verdigris Coulee	35,000	17
West Barons	15,000	18
Foremost	40,000	19
Pakowki	35,000	20
South Magrath	8,400	21
Albion Ridge	29,700	22
Barons	14,000	23
Summerview	7,000	24
Peigan Indian Reserve	17,000	25
Total	622,750	

Source: Stanley/SLN 1978.

17.6 APPENDIX 6: ASSESSED IRRIGATED ACREAGE* IN THE OLDMAN RIVER BASIN

1969-1977 and Trend Line Projections to 1995 (in thousands of acres)

	Actual									Projected			
Irrigation District	1969	1970	1971	1972	1973	1974	1975	1976	1977	1980	1985	1990	1995
St. Mary River	194.2	197.5	199.6	204.1	215.1	236.0	252.0	262.2	274.3				
Magrath	8.5	8.5	8.1	9.0	9.2	9.1	8.9	9.1	9.5				
Raymond	20.8	20.8	20.3	20.3	20.6	23.3	26.9	28.4	31.6				
Taber	56.5	57.5	59.2	59.8	61.7	63.8	62.7	63.3	68.2				
St. Mary Project Sub-Total	280.0	284.3	287.6	293.2	306.6	332.2	350.5	363.0	383.6	415.3	483.3	551.3	619.3
Lethbridge Northern	89.4	89.4	89.7	89.4	98.2	104.3	108.1	109.6	111.7	122.4	139.2	156.0	172.8

Data supplied by Irrigation Secretariat and Irrigation Districts

*excludes acres under commuted rates

17.7 APPENDIX 7

ACRES

March 2, 1979
P4699.05

Mr John Lilley
Senior Research Officer
Environment Council of Alberta
2100 College Plaza Tower 3
8215 - 112 Street
Edmonton, Alberta
T6G 2M4

Dear Mr Lilley

Oldman River Basin Water Balance Model

As requested verbally by you on February 28, we have prepared the following information and forward it attached herewith:

1. Flow Duration Data in the Oldman River at Lethbridge

   The monthly flow duration data for the Oldman River at Lethbridge for:

   a) 50/75 apportionment, Near Future case (Acres run #106-3B), and

   b) 50/75 apportionment, Far Future case (Acres run #211-1B)

   are shown in Tables I and II respectively. The period of simulation is 1927 to 1944 inclusive.

2. Quantity of Water Pumped to Chin Reservoir and Cost of Pumping

   a) The monthly volume of water pumped to the Chin Reservoir together with the average annual volume pumped given in acre-feet for the year 1912 to 1973 inclusive, are shown on Table III. This data has been extracted from Acres run #211-1E.

ACRES CONSULTING SERVICES LIMITED
Suite 450 - 6712 Fisher St. SE, Calgary, Canada T2H 2A7
Telephone 403-253-9161
Telex 03-825582

Toronto, Burlington, Calgary, Halifax, Niagara Falls, Vancouver, Winnipeg

b) The cost of pumping has been calculated using data obtained from the Klohn Leonoff report "Oldman River Basin, Phase II Study, Water Supply Alternatives".

Table IV identifies the capital cost amortized over the expected useful life of the station as well as the annual operating and maintenance charges.

Table V shows the energy cost of pumping the volume of water reported on Table III.

Table VI indicates the total fixed cost plus energy costs for pumping annually for the years 1912 to 1973 inclusive.

We trust that the attached tables will give you the information that you requested. If we can assist in the interpretation of the data or offer any further assistance, please do not hesitate to contact us.

Yours sincerely

Gloin

L O Gloin
Regional Manager

LOG:BS
Encs

cc: Mr L K Szojka

TABLE I: FLOW DURATION (CFS) AT LETHBRIDGE - NEAR FUTURE CASE *

FREQUENCY OF FLOW EXCEEDING %	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
100	363	363	468	401	1372	766	363	363	363	363	363	363
94.4	363	375	470	436	1438	1145	394	363	363	363	454	363
88.9	389	383	498	439	1556	1659	472	441	363	363	501	363
83.3	395	438	550	461	1948	1825	473	445	458	424	534	413
77.8	408	448	553	521	1960	2195	505	455	493	435	544	420
72.2	422	460	706	553	2291	2832	587	503	500	449	552	426
66.7	482	462	722	558	3268	3356	713	530	541	478	584	481
61.1	491	466	813	624	3295	5752	715	583	549	489	595	506
55.6	511	474	854	649	3621	6386	961	646	602	509	679	520
50.0	527	484	892	693	3842	6760	962	752	651	529	708	529
44.4	541	493	1207	695	4943	6785	1091	765	727	572	747	579
38.9	554	507	1262	772	5947	7132	1385	823	768	680	808	591
33.3	589	547	1456	979	6264	7460	1703	888	770	689	850	718
27.8	631	732	1618	1225	6641	9321	1998	975	967	866	900	816
22.2	667	1133	1664	1664	8719	9942	4181	1211	1024	935	1655	863
16.7	975	1430	1844	2750	8862	10324	6229	1395	1037	1016	1754	920
11.1	1685	1798	1959	3540	10093	15876	8569	1582	1320	2031	2195	1480
5.6	3225	1987	3583	5342	10781	23717	10578	3295	6207	6895	2540	1520

* Oldman River Study: Acres Run No 106-3B

TABLE II: FLOW DURATION (CFS) AT LETHBRIDGE - FAR FUTURE CASE *

JAN		FEB		MAR		APR		MAY		JUN	
PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW
100.0	363.0	100.0	363.0	100.0	422.4	100.0	363.0	100.0	868.6	100.0	855.9
98.4	363.0	98.4	363.0	98.4	438.7	98.4	446.2	98.4	992.7	98.4	1149.9
96.8	363.0	96.8	376.0	96.8	446.8	96.8	489.1	96.8	1611.6	96.8	1469.1
95.2	382.5	95.2	382.9	95.2	471.4	95.2	491.2	95.2	1630.6	95.2	1635.2
93.5	390.7	93.5	395.4	93.5	489.4	93.5	535.1	93.5	1751.2	93.5	1813.2
91.9	406.4	91.9	401.8	91.9	497.5	91.9	544.2	91.9	1831.2	91.9	1829.1
90.3	407.7	90.3	435.9	90.3	516.4	90.3	555.2	90.3	1841.6	90.3	1885.9
88.7	419.7	88.7	437.9	88.7	517.8	88.7	574.7	88.7	1843.3	88.7	2059.4
87.1	420.2	87.1	459.9	87.1	542.4	87.1	583.1	87.1	1883.1	87.1	2096.0
85.5	432.7	85.5	461.9	85.5	543.4	85.5	624.1	85.5	1948.7	85.5	2551.6
83.9	449.7	83.9	465.9	83.9	548.4	83.9	633.2	83.9	1967.0	83.9	2798.3
82.3	449.9	82.3	465.9	82.3	550.4	82.3	637.2	82.3	2021.4	82.3	2821.8
80.6	450.7	80.6	467.9	80.6	550.4	80.6	673.6	80.6	2077.3	80.6	3138.9
79.0	455.9	79.0	473.9	79.0	588.3	79.0	680.1	79.0	2315.3	79.0	3214.4
77.4	456.0	77.4	479.3	77.4	604.5	77.4	754.0	77.4	2325.5	77.4	3574.9
75.8	459.7	75.8	481.4	75.8	605.5	75.8	795.1	75.8	2394.3	75.8	3666.5
74.2	462.7	74.2	483.3	74.2	675.5	74.2	811.2	74.2	2498.0	74.2	3906.9
72.6	468.4	72.6	483.9	72.6	677.0	72.6	859.1	72.6	2498.5	72.6	3977.9
71.0	471.7	71.0	505.4	71.0	697.3	71.0	874.7	71.0	2700.0	71.0	4153.0
69.4	475.0	69.4	506.9	69.4	755.4	69.4	885.7	69.4	2702.0	69.4	4211.9
67.7	481.7	67.7	523.8	67.7	775.7	67.7	886.1	67.7	2714.9	67.7	4354.6
66.1	490.7	66.1	534.4	66.1	788.4	66.1	886.2	66.1	2856.5	66.1	4427.5
64.5	508.7	64.5	575.5	64.5	788.5	64.5	914.3	64.5	2913.7	64.5	4447.9
62.9	510.3	62.9	603.9	62.9	820.8	62.9	923.9	62.9	2917.4	62.9	4600.2
61.3	510.7	61.3	606.5	61.3	834.7	61.3	1037.9	61.3	3518.4	61.3	4966.9
59.7	515.7	59.7	700.9	59.7	902.1	59.7	1176.7	59.7	3528.2	59.7	5135.0
58.1	520.1	58.1	729.1	58.1	919.8	58.1	1219.8	58.1	3583.3	58.1	5390.9
56.5	522.4	56.5	760.2	56.5	952.9	56.5	1254.7	56.5	3866.5	56.5	5406.4
54.8	528.8	54.8	832.6	54.8	971.6	54.8	1278.7	54.8	4103.0	54.8	5432.8
53.2	530.4	53.2	932.1	53.2	978.7	53.2	1314.4	53.2	4222.6	53.2	5958.8
51.6	535.3	51.6	951.8	51.6	1016.5	51.6	1320.2	51.6	4237.2	51.6	6344.6
50.0	540.6	50.0	969.0	50.0	1133.5	50.0	1341.2	50.0	4326.5	50.0	6472.3
48.4	540.7	48.4	1068.8	48.4	1155.5	48.4	1352.8	48.4	4447.7	48.4	6529.0
46.8	559.2	46.8	1079.7	46.8	1166.8	46.8	1464.0	46.8	4451.7	46.8	6811.9
45.2	563.7	45.2	1106.4	45.2	1175.7	45.2	1609.3	45.2	4511.6	45.2	7343.9
43.5	564.4	43.5	1291.3	43.5	1278.9	43.5	1613.7	43.5	4695.4	43.5	7347.5
41.9	590.7	41.9	1392.2	41.9	1284.5	41.9	1885.0	41.9	4915.0	41.9	7580.8
40.3	616.0	40.3	1681.6	40.3	1320.6	40.3	1986.5	40.3	5195.6	40.3	7666.5
38.7	619.7	38.7	1728.0	38.7	1336.6	38.7	2041.0	38.7	5221.2	38.7	7823.8
37.1	620.3	37.1	1730.6	37.1	1337.9	37.1	2057.0	37.1	5485.1	37.1	8509.8
35.5	633.8	35.5	1790.9	35.5	1359.6	35.5	2076.4	35.5	5691.8	35.5	8751.8
33.9	634.7	33.9	1949.4	33.9	1391.4	33.9	2300.5	33.9	5874.5	33.9	8897.3
32.3	649.4	32.3	1950.5	32.3	1465.5	32.3	2350.8	32.3	5893.1	32.3	9131.7
30.6	654.5	30.6	2083.1	30.6	1539.5	30.6	2379.0	30.6	6211.8	30.6	9286.5
29.0	665.8	29.0	2219.4	29.0	1562.7	29.0	2426.5	29.0	6253.3	29.0	9342.3
27.4	679.5	27.4	2312.6	27.4	1631.5	27.4	2457.2	27.4	6281.6	27.4	9678.9
25.8	713.1	25.8	2349.8	25.8	1679.6	25.8	2507.1	25.8	6336.2	25.8	10150.9
24.2	714.3	24.2	2373.3	24.2	1686.3	24.2	2520.4	24.2	6421.9	24.2	10249.2
22.6	716.8	22.6	2376.7	22.6	1764.7	22.6	2657.7	22.6	6829.2	22.6	10806.1
21.0	728.9	21.0	2461.2	21.0	1849.2	21.0	2706.8	21.0	6890.7	21.0	11177.5
19.4	730.7	19.4	2466.7	19.4	1854.0	19.4	2749.7	19.4	7677.8	19.4	12030.8
17.7	743.1	17.7	2496.9	17.7	1861.3	17.7	2772.7	17.7	8365.3	17.7	12547.6
16.1	852.7	16.1	2515.8	16.1	1865.5	16.1	3079.3	16.1	8916.7	16.1	13947.1
14.5	863.7	14.5	2545.0	14.5	1951.7	14.5	3103.1	14.5	9018.8	14.5	14151.1
12.9	879.9	12.9	2585.5	12.9	2292.9	12.9	3147.2	12.9	9420.6	12.9	14336.9
11.3	886.3	11.3	2589.8	11.3	2535.9	11.3	3717.2	11.3	9704.6	11.3	16337.0
9.7	913.9	9.7	2593.9	9.7	2954.6	9.7	3950.2	9.7	9810.7	9.7	17221.7
8.1	973.2	8.1	2627.2	8.1	2978.6	8.1	3999.8	8.1	10119.6	8.1	17761.1
6.5	974.5	6.5	2651.2	6.5	3168.8	6.5	5564.1	6.5	11022.5	6.5	19321.1
4.8	1009.1	4.8	2909.2	4.8	3590.9	4.8	5875.6	4.8	11898.0	4.8	22601.8
3.2	1563.4	3.2	3215.2	3.2	3644.6	3.2	6334.0	3.2	14456.5	3.2	26844.3
1.6	3227.6	1.6	4693.0	1.6	3986.1	1.6	7046.2	1.6	15821.7	1.6	28832.5
MEAN	537.9		960.		1075.		1331.		4282.		6408.

* Oldman River Study: Acres Run No 211-1B

TABLE II (contd) FLOW DURATION (CFS) AT LETHBRIDGE - FAR FUTURE CASE *

JUL		AUG		SEP		OCT		NOV		DEC	
PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW	PERCENT	FLOW
100.0	363.0	100.0	394.5	100.0	403.0	100.0	363.0	100.0	363.0	100.0	363.0
98.4	444.5	98.4	400.5	98.4	409.0	98.4	363.0	98.4	429.8	98.4	365.1
96.8	464.5	96.8	407.4	96.8	442.9	96.8	382.7	96.8	437.8	96.8	393.4
95.2	533.2	95.2	519.5	95.2	454.0	95.2	393.2	95.2	456.4	95.2	401.7
93.5	637.2	93.5	534.4	93.5	482.5	93.5	412.0	93.5	476.4	93.5	405.7
91.9	659.2	91.9	589.7	91.9	520.8	91.9	433.0	91.9	478.7	91.9	410.4
90.3	700.3	90.3	596.5	90.3	532.8	90.3	442.0	90.3	490.9	90.3	411.2
88.7	727.2	88.7	606.4	88.7	545.0	88.7	470.0	88.7	500.8	88.7	423.4
87.1	772.2	87.1	610.7	87.1	551.0	87.1	483.5	87.1	501.8	87.1	425.7
85.5	806.2	85.5	613.8	85.5	566.0	85.5	487.8	85.5	506.8	85.5	427.4
83.9	871.3	83.9	637.4	83.9	572.0	83.9	493.7	83.9	516.2	83.9	429.7
82.3	886.1	82.3	688.6	82.3	587.3	82.3	504.7	82.3	533.8	82.3	430.7
80.6	896.2	80.6	692.9	80.6	588.8	80.6	519.0	80.6	538.8	80.6	441.3
79.0	939.1	79.0	698.5	79.0	590.0	79.0	522.7	79.0	542.8	79.0	450.0
77.4	972.1	77.4	712.4	77.4	624.0	77.4	523.7	77.4	543.8	77.4	455.5
75.8	994.5	75.8	753.7	75.8	627.8	75.8	534.7	75.8	546.3	75.8	458.2
74.2	1034.5	74.2	770.4	74.2	633.0	74.2	544.5	74.2	546.4	74.2	459.5
72.6	1050.2	72.6	788.4	72.6	639.7	72.6	548.5	72.6	547.8	72.6	468.2
71.0	1106.2	71.0	794.4	71.0	646.0	71.0	550.7	71.0	551.8	71.0	476.5
69.4	1151.6	69.4	811.4	69.4	662.5	69.4	556.7	69.4	574.5	69.4	478.4
67.7	1177.3	67.7	830.4	67.7	679.0	67.7	561.0	67.7	591.8	67.7	501.1
66.1	1213.2	66.1	839.4	66.1	681.4	66.1	571.8	66.1	594.8	66.1	505.7
64.5	1227.2	64.5	872.4	64.5	710.0	64.5	589.7	64.5	598.3	64.5	518.2
62.9	1272.9	62.9	887.4	62.9	729.0	62.9	597.0	62.9	609.8	62.9	520.2
61.3	1468.1	61.3	895.3	61.3	732.0	61.3	597.7	61.3	645.8	61.3	534.0
59.7	1576.2	59.7	898.6	59.7	744.6	59.7	603.0	59.7	647.9	59.7	545.9
58.1	1673.4	58.1	912.4	58.1	748.0	58.1	613.0	58.1	648.8	58.1	559.2
56.5	1774.2	56.5	936.8	56.5	748.1	56.5	615.0	56.5	652.6	56.5	570.4
54.8	1784.8	54.8	946.4	54.8	764.4	54.8	628.0	54.8	662.1	54.8	571.2
53.2	1943.7	53.2	974.6	53.2	764.6	53.2	628.0	53.2	681.3	53.2	575.9
51.6	2016.3	51.6	994.4	51.6	781.6	51.6	632.7	51.6	684.4	51.6	577.7
50.0	2126.6	50.0	1000.8	50.0	798.0	50.0	667.0	50.0	690.8	50.0	591.7
48.4	2168.2	48.4	1035.7	48.4	803.0	48.4	680.2	48.4	696.5	48.4	598.3
46.8	2285.9	46.8	1044.5	46.8	810.5	46.8	694.5	46.8	718.8	46.8	601.0
45.2	2327.4	45.2	1074.2	45.2	820.5	45.2	696.7	45.2	734.7	45.2	604.7
43.5	2382.2	43.5	1076.4	43.5	831.0	43.5	703.0	43.5	737.3	43.5	607.0
41.9	2424.2	41.9	1136.9	41.9	841.0	41.9	740.0	41.9	737.8	41.9	613.7
40.3	2458.3	40.3	1176.3	40.3	872.0	40.3	755.2	40.3	767.8	40.3	619.7
38.7	2585.0	38.7	1179.1	38.7	901.0	38.7	762.0	38.7	775.0	38.7	640.1
37.1	2757.8	37.1	1208.9	37.1	951.2	37.1	786.0	37.1	790.5	37.1	646.2
35.5	2915.0	35.5	1217.4	35.5	960.4	35.5	788.0	35.5	890.8	35.5	661.6
33.9	2996.2	33.9	1355.4	33.9	974.0	33.9	809.1	33.9	911.8	33.9	688.2
32.3	3101.9	32.3	1365.2	32.3	974.6	32.3	839.8	32.3	966.6	32.3	718.4
30.6	3304.5	30.6	1386.8	30.6	976.0	30.6	852.1	30.6	1029.2	30.6	733.7
29.0	3377.7	29.0	1434.6	29.0	1032.8	29.0	852.2	29.0	1033.2	29.0	734.6
27.4	3452.6	27.4	1436.2	27.4	1048.2	27.4	854.7	27.4	1077.1	27.4	757.7
25.8	4089.4	25.8	1471.4	25.8	1048.9	25.8	906.4	25.8	1170.2	25.8	784.5
24.2	4138.5	24.2	1525.3	24.2	1089.0	24.2	959.0	24.2	1172.9	24.2	801.1
22.6	4152.3	22.6	1550.7	22.6	1092.1	22.6	972.0	22.6	1194.0	22.6	848.5
21.0	4304.8	21.0	1564.4	21.0	1154.8	21.0	1005.0	21.0	1236.8	21.0	875.5
19.4	4676.1	19.4	1574.6	19.4	1211.0	19.4	1293.5	19.4	1250.7	19.4	920.1
17.7	4699.8	17.7	1638.2	17.7	1232.4	17.7	1326.7	17.7	1470.6	17.7	939.3
16.1	4858.5	16.1	1705.4	16.1	1252.1	16.1	1743.4	16.1	1587.0	16.1	969.2
14.5	4942.4	14.5	1724.6	14.5	1257.2	14.5	1880.0	14.5	1612.9	14.5	1038.6
12.9	5186.9	12.9	1734.0	12.9	1300.5	12.9	2108.5	12.9	1712.7	12.9	1067.5
11.3	5317.0	11.3	1751.5	11.3	1344.4	11.3	2282.7	11.3	1745.8	11.3	1164.8
9.7	5871.2	9.7	1782.8	9.7	1349.7	9.7	2532.8	9.7	1780.7	9.7	1213.6
8.1	6279.3	8.1	1839.0	8.1	1358.7	8.1	2740.3	8.1	1819.5	8.1	1484.3
6.5	8198.2	6.5	2303.3	6.5	1507.0	6.5	2823.1	6.5	2225.9	6.5	1489.3
4.8	8775.0	4.8	2502.9	4.8	2013.3	4.8	4135.7	4.8	2408.7	4.8	1567.0
3.2	9667.9	3.2	2998.3	3.2	6011.1	3.2	6776.3	3.2	2558.6	3.2	1785.7
1.6	11929.8	1.6	3542.5	1.6	7594.0	1.6	7605.3	1.6	2723.6	1.6	2292.5
MEAN	2071.4		998.		790.		650.		688.		585.

* Oldman River Study: Acres Run No 211-1B

TABLE III: PUMPING TO TABER (ACRE-FEET)

YEAR	MAY	JUNE	JULY	AUG	SEPT	OCT	TOTAL	AVERAGE*
1912	48265	-	15775	42638	11073	-	117751	29438
1913	11888	-	46439	879	13471	17312	89989	17998
1914	-	-	30381	72933	15565	-	118879	39626
1915	-	-	5658	52207	3576	-	61441	20480
1916	-	-	-	135	-	-	135	135
1917	-	-	83068	-	9395	17017	109480	36493
1918	48628	12507	55910	560	-	1513	119118	23824
1919	67632	-	-	-	38764	11162	117558	39186
1920	85116	92250	77416	-	-	-	254782	84927
1921	11150	-	10191	-	-	-	21341	10671
1922	-	13465	-	-	-	-	13465	13465
1923	-	92250	92250	4766	-	-	189266	63089
1924	-	-	3260	50123	52146	-	105529	35176
1925	-	-	2466	39907	-	18063	60436	20145
1926	-	-	79932	-	61226	30424	171582	57194
1927	-	-	-	-	-	-	-	-
1928	-	-	40602	2565	14530	59009	116706	29177
1929	-	-	11070	63892	13875	-	88837	29612
1930	-	-	9120	-	-	14619	23739	11870
1931	-	-	25369	44268	22551	17331	109519	27380
1932	14717	92250	92250	-	39109	-	238326	59582
1933	56070	-	2522	-	-	-	58592	29296
1934	-	-	22337	29336	13393	7423	72489	18122
1935	52466	-	-	-	-	572	53038	26519
1936	-	30494	-	25369	65748	12042	133653	33413
1937	35240	92250	55086	37447	58923	6544	285490	47582
1938	37749	92250	37909	43173	732	-	211813	42363
1939	-	57043	57355	14883	-	38222	167503	41876
1940	18081	45256	-	-	41311	4711	109359	27340
1941	2528	-	51949	9502	48701	32816	145496	29099
1942	22460	88536	57632	51709	42049	-	262386	52477
1943	-	11049	92250	6525	52824	-	162648	40662
1944	-	-	2491	-	20176	-	22667	11334
1945	39668	92250	64157	22933	1059	15166	177493	29582
1946	-	63635	-	-	-	15941	79576	39788
1947	55922	-	13155	-	5456	48357	122890	30723
1948	-	-	70614	92250	-	-	162864	81432
1949	-	-	6291	92250	1000	-	93541	31180
1950	22866	-	81813	-	-	-	104679	52340
1951	-	-	2054	-	-	-	2054	2054
1952	-	-	44729	38751	9978	3432	96890	24223
1953	-	-	-	4268	-	-	4268	2268
1954	-	-	37023	-	26698	-	63721	31861
1955	-	-	-	-	-	-	-	-
1956	-	-	19053	30695	25276	15172	90196	22549
1957	-	-	29471	46691	35956	2011	114129	28532
1958	65608	-	92250	5781	32505	-	196144	49036
1959	-	-	47939	2159	-	41310	91408	30469
1960	-	-	15221	77847	-	-	93068	46534
1961	62613	-	1913	-	-	6433	70959	23653
1962	66949	-	-	5098	-	13745	85792	28597
1963	-	92250	60547	-	23919	8973	185689	46422
1964	61039	66777	49132	-	-	7915	184863	46216
1965	30424	-	16513	2300	48754	-	97991	24498
1966	-	-	16341	-	1833	3979	22153	7384
1967	-	-	51297	-	-	-	51297	51297
1968	25430	-	-	-	-	-	25430	25430
1969	-	-	92250	2466	48915	8223	151854	37964
1970	57226	-	11703	72263	9014	4533	154739	30948
1971	10295	-	21027	20812	-	-	52134	17378
1972	-	-	66069	1359	-	18985	86413	28804
1973	-	-	19969	48997	-	14391	83357	27786

* average is calculated by dividing the total amount by the number of months that require pumping.

TABLE IV: CHIN PUMP STATION

DESCRIPTION	AMORTIZATION PERIOD(YEAR)	ANNUAL DEPRECIATION($)	ANNUAL OPERATION * AND MAINTENANCE($)	SUB-TOTAL
Earthwork	100	19,080	1,910	20,990
Land	100	1,750	0	1,750
Structural	50	125,560	12,560	138,120
Electrical/Mechanical	25	410,040	153,760	563,800
			TOTAL:	724,660

Energy Consumed *	408 kWh/AF
Energy Cost Per Acre-Foot Pumped *	$8.16

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* Data taken from 'Oldman River Basin Phase II Study Water Supply Alternatives' Appendix H, Table H4 by Klohn Leonoff Consultants Ltd.

TABLE V: ENERGY COST FOR PUMPING ($)

Year	May	June	July	Aug	Sept	Oct	Total	Average*
1912	393842	-	128724	347926	90356	-	960848	240214
1913	97006	-	378942	7173	109923	141266	734310	146864
1914	-	-	247909	595133	127010	-	970053	323348
1915	-	-	46169	426009	29180	-	501359	167117
1916	-	-	-	1102	-	-	1102	1102
1917	-	-	677835	-	76663	138859	893357	297783
1918	396804	102057	456226	4570	-	12346	972003	194404
1919	551877	-	-	-	316314	91082	959273	319758
1920	694547	752760	631715	-	-	-	2079021	693004
1921	90984	-	83159	-	-	-	174143	87075
1922	-	109874	-	-	-	-	109874	109874
1923	-	752760	752760	38891	-	-	1544411	514806
1924	-	-	26602	409004	425511	-	861117	287036
1925	-	-	20123	325641	-	147394	493158	164383
1926	-	-	652245	-	499604	248260	1400109	466703
1927	-	-	-	-	-	-	-	-
1928	-	-	331312	20930	118565	481513	952321	238084
1929	-	-	90331	521359	113220	-	724910	241634
1930	-	-	74419	-	-	119291	193710	96859
1931	-	-	207011	361227	184016	141421	893675	223421
1932	120091	752760	752760	-	319129	-	1944740	486189
1933	457531	-	20580	-	-	-	478111	239055
1934	-	-	182270	239382	109287	60572	591510	147876
1935	428123	-	-	-	-	4668	432790	216395
1936	-	248831	-	207011	536504	98263	1090608	272650
1937	287558	752760	449502	305568	480812	53399	2329598	388269
1938	308032	752760	309337	352292	5973	-	1728394	345682
1939	-	465471	468017	121445	-	311892	1366824	341708
1940	147541	369289	-	-	337098	38442	892369	223094
1941	20628	-	423904	77536	397400	267779	1187247	237448
1942	183274	722454	470277	421945	343120	-	2141070	428212
1943	-	90160	752760	53244	431044	-	1327208	331802
1944	-	-	20327	-	164636	-	184963	92485
1945	323691	752760	523521	187133	8641	123755	1448343	241389
1946	-	519262	-	-	-	130079	649340	324670
1947	456324	-	107345	-	44521	394593	1002782	250700
1948	-	-	576210	752760	-	-	1328970	664485
1949	-	-	51335	752760	8160	-	763295	254429
1950	186587	-	667594	-	-	-	854181	427094
1951	-	-	16761	-	-	-	16761	16761
1952	-	-	364989	316208	81420	28005	790622	197660
1953	-	-	-	34827	-	-	34827	34827
1954	-	-	302108	-	217856	-	519963	259986
1955	-	-	-	-	-	-	-	-
1956	-	-	155472	250471	206252	123804	735999	184000
1957	-	-	240483	380999	293401	16410	931293	232821
1958	535361	-	752760	47173	265241	-	1600535	400134
1959	-	-	391182	17617	-	337090	745889	248627
1960	-	-	124203	635232	-	-	759435	379717
1961	510922	-	15610	-	-	52493	579025	193008
1962	546385	-	-	41600	-	112159	700063	233352
1963	-	752760	294064	-	195179	73220	1515222	378804
1964	498078	544900	400917	-	-	64586	1508482	377123
1965	248260	-	134746	18768	397833	-	799607	199904
1966	-	-	133343	-	14957	32469	180768	60253
1967	-	-	418584	-	-	-	418584	418584
1968	207509	-	-	-	-	-	207509	207509
1969	-	-	752760	20123	399146	67100	1239129	309786
1970	466964	-	95496	589666	73554	36989	1262670	252536
1971	84007	-	171580	169826	-	-	425413	141804
1972	-	-	539123	11089	-	154918	705130	235041
1973	-	-	162947	399816	-	117431	680193	226734

* Average is calculated by dividing the total by the number of months that require pumping

TABLE VI: TOTAL COST (THOUSAND DOLLARS)

Year	Fixed Cost	Energy Cost	Total Cost
1912	725	961	1686
1913	"	734	1459
1914	"	970	1694
1915	"	501	1226
1916	"	1	726
1917	"	893	1618
1918	"	972	1697
1919	"	959	1684
1920	"	2079	2804
1921	725	174	899
1922	"	110	835
1923	"	1544	2269
1924	"	861	1586
1925	"	493	1218
1926	"	1400	2125
1927	"	0	725
1928	"	952	1677
1929	"	725	1450
1930	"	194	919
1931	725	894	1619
1932	"	1945	2670
1933	"	478	1203
1934	"	591	1316
1935	"	433	1158
1936	"	1091	1816
1937	"	2330	3055
1938	"	1728	2453
1939	"	1367	2092
1940	"	892	1617
1941	725	1187	1912
1942	"	2141	2866
1943	"	1327	2052
1944	"	185	910
1945	"	1448	2173
1946	"	649	1374
1947	"	1003	1728
1948	"	1329	2054
1949	"	763	1488
1950	"	854	1579
1951	725	17	742
1952	"	791	1516
1953	"	35	760
1954	"	520	1245
1955	"	0	725
1956	"	736	1461
1957	"	931	1656
1958	"	1600	2325
1959	"	746	1471
1960	"	759	1484
1961	725	579	1304
1962	"	700	1425
1963	"	1515	2240
1964	"	1508	2233
1965	"	799	1524
1966	"	181	906
1967	"	418	1143
1968	"	207	932
1969	"	1239	1964
1970	"	1263	1988
1971	725	425	1150
1972	"	705	1430
1973	"	680	1405
		TOTAL:	98449
		MEAN:	1588

17.8 APPENDIX 8: STUDIES ON WATER BASIN MANAGEMENT

This is a brief list of studies which will provide readers with a starting point for further study of Water Basin Management.

Alberta Environment. 1976. *An Assessment of Alternatives to a Dam on the Red Deer River.* Edmonton: Alberta Environment, Planning Division.

Alberta Environment. 1976. *Red Deer River Basin: Preliminary Planning Report on Potential Damsites Upstream from Sundre.* Edmonton: Alberta Environment, Planning Division.

Alberta Environment. 1976. *Red Deer River Today and Tomorrow: A Management Statement.* Edmonton: Alberta Environment, Planning Division.

Alberta Environment. 1975. *Red Deer River Flow Regulation Planning Studies.* 7 Vols. Edmonton: Alberta Environment, Environmental Planning Division.

Alberta Environment. 1974. *Preliminary Planning Report on Paddle River Development.* Edmonton: Alberta Environment, Environmental Planning Division.

Alberta Environment. 1974. *A Summary Report on the Paddle River Study.* Edmonton: Alberta Environment, Environmental Planning Division.

Alberta Environment. 1974. *The Vermilion River Basin Study: A Summary Report.* Edmonton: Alberta Environment, Environmental Planning Division.

Agassiz Center for Water Studies. 1974. *The Allocative Conflicts in Water-Resource Management.* Winnipeg: University of Manitoba.

Benedict, A. H., Hall, K. J., and Koch, F. A. n.d. *A Preliminary Water Quality Survey of The Lower Fraser River System.* Westwater Research Centre Technical Report No. 2) Vancouver: University of British Columbia, Westwater Research Centre.

Biswas, Asit K. (ed.). 1978. *United Nations Water Conference: Summary and Main Documents.* Oxford: Pergamon Press.

Bolter Parish Trimble Ltd. 1976. *Vermilion River Vegreville Study.* Edmonton: Alberta Environment.

Canada. Department of Environment. 1975. *Monograph on Comprehensive River Basin Planning.* Ottawa: Department of Environment.

Canada. Department of Fisheries and Environment. 1979. *Canada Water Year Book, 1977-78.* Ottawa: Department of Fisheries and Environment.

Canada - British Columbia Consultative Board. 1974. *Summary Report of the Consultative Board Including the Comprehensive Framework Plan. Prepared Under the Canada - British Columbia Okanagan Basin Agreement.* Victoria: British Columbia Water Resources Service.

Canada - British Columbia Fraser River Joint Advisory Board. 1976. *Fraser River Upstream Storage Review Report.* Victoria: Canada - British Columbia Fraser River Joint Advisory Board.

Canadian Water Resources Journal. Published for the Canadian Water Resources Association by the University of Toronto Press.

Dorcey, Anthony H. J. (ed.). 1976. *The Uncertain Future of the Lower Fraser.* Vancouver: University of British Columbia, Westwater Research Centre.

Environment Conservation Authority. 1977. *Flow Regulation of the Red Deer River: Report and Recommendations.* Edmonton: Environment Conservation Authority.

Environment Conservation Authority. 1976. *Flow Regulation in the Red Deer River: Preliminary Report and Recommendations.* Edmonton: Environment Conservation Authority.

Environment Conservation Authority. 1975. *Flood Control and Water Management in the Paddle River Basin: Report and Recommendations.* Edmonton: Environment Conservation Authority.

Environment Conservation Authority. 1974. *The Restoration of Water Levels in the Peace-Athabasca Delta: Report and Recommendations.* Edmonton: Environment Conservation Authority.

Fairbairn, B. and Peterson, K. n.d. *Controlling Sawlog Debris in the Lower Fraser River.* (Westwater Research Centre Technical Report No. 5). Vancouver: University of British Columbia, Westwater Research Centre.

Fraser River Board. 1963. *Final Report of the Fraser River Board on Flood Control and Hydro-electric Power in the Fraser River Basin.* 2 Vols. Victoria: Fraser River Board.

Hall, K.J., Koch, F.A., and Yesaki, I. n.d. *Further Investigations into Water Quality Conditions in the Lower Fraser River System.* (Westwater Research Centre Technical Report No. 4) Vancouver: University of British Columbia, Westwater Research Centre.

Johnston, N.T., Albright, L.J., Northcote, T.G., Oloffs, P.C., and Tsumura, K. n.d. *Chlorinated Hydrocarbon Residues in Fishes From the Lower Fraser River.* (Westwater Research Centre Technical Report No. 9) Vancouver: University of British Columbia, Westwater Research Centre.

Joy, C.S. n.d. *Water Quality Models of the Lower Fraser River.* (Westwater Research Centre Technical Report No. 6.) Vancouver: University of British Columbia, Westwater Research Centre.

Northcote, T.G. n.d. *Biology of the Lower Fraser River System: A Review.* (Westwater Research Centre Technical Report No. 3.) Vancouver: University of British Columbia, Westwater Research Centre.

Northcote, T.G., Ennis, G.L., and Anderson, M.H. n.d. *Periphytic and Planktonic Algae of the Lower Fraser River in Relation to Water Quality Conditions.* (Westwater Research Centre Technical Report No. 8.) Vancouver: University of British Columbia, Westwater Research Centre.

Northcote, T.G., Johnston, N.T., and Tsumura, K. n.d. *Trace Metal Concentrations in Lower Fraser River Fishes.* (Westwater Research Centre Technical Report No. 7) Vancouver: University of British Columbia, Westwater Research Centre.

Paddle River Basin Land Use and Water Management Committee. 1978. *The Paddle River Basin Land Use and Water Management Committee Report.* Edmonton: Alberta Environment.

Peace-Athabasca Delta Project Group. 1973. *The Peace Athabasca Delta Project. Technical Report.* 4 Vols. Edmonton: Peace-Athabasca Delta Project Group.

Peace-Athabasca Delta Project Group. 1972. *The Peace-Athabasca Delta: A Canadian Resource.* Edmonton: Peace-Athabasca Delta Project Group.

Qu'Appelle Basin Study Board. 1972. *Report of the Qu'Appelle Basin Study Board.* Regina: Qu'Appelle Basin Study Board.

Reid Crowther and Partners Ltd., Bolter Parish and Trimble Ltd., Pollecol Ltd., and EARM and Ranch Management Consultants Ltd. 1974. *Vermilion River Basin Study.* 2 Vols. Edmonton: Alberta Department of the Environment, Environmental Planning Division.

Saint John River Basin Board. 1975. *A Plan for Water Management in the Saint John River Basin: Final Report of the Saint John River Basin Board.* 3 Vols. Fredericton: Saint John River Basin Board.

St. Lawrence River Water Quality Committee. 1979. *A Plan for the St. Lawrence. Summary of the Final Report Submitted by the St. Lawrence River Water Quality Committee.* Sillery, P.Q.: Science Forum.

Saskatchewan. Department of the Environment. 1973. *The Proposed Peace-Athabasca Control Structure: Saskatchewan Assessment.* Regina: Department of the Environment.

Saskatchewan-Nelson Basin Board. 1972. *Water Supply for the Saskatchewan-Nelson Basin: Report of the Saskatchewan-Nelson Basin Board.* 10 Vols. Saskatoon: Saskatchewan-Nelson Basin Board.

Smith, S.B. n.d. *The Peace-Athabasca Delta: A Choice of Water Management Alternatives.* Edmonton: Alberta Environment.

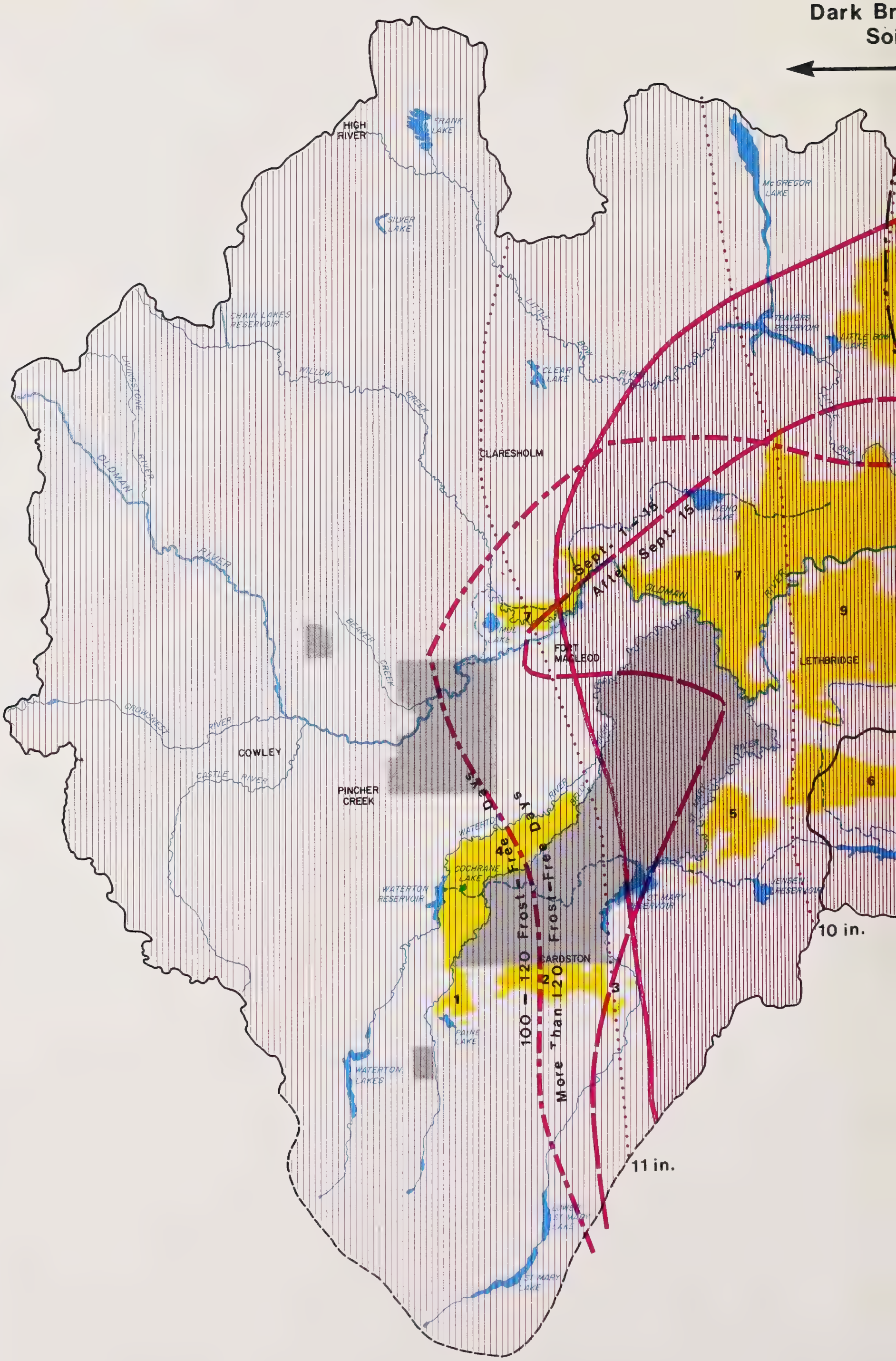
Souris River Basin Study Board. 1978. *Souris River Basin Study: Report.* Regina: Souris River Basin Study Board.

LEGEND

Mountain View Irrigation District	1
Leavitt Irrigation District	2
Aetna Irrigation District	3
United Irrigation District	4
Magrath Irrigation District	5
Raymond Irrigation District	6
Lethbridge Northern Irrigation District	7
Taber Irrigation District	8
St. Mary River Irrigation District	9
Ross Creek Irrigation District	10
Bow River Irrigation District	11
Mean Precipitation During Growing Season (April – August)	....
First Fall Frost	— —
Frost – Free Days	—·—·—·
Soil Zone Boundary	- — - —

Degree Days (in hundreds)

24	27	30
▯	▥	▥


Dark Br
Soi
HIGH RIVER
FRANK LAKE
SILVER LAKE
McGREGOR LAKE
CHAIN LAKES RESERVOIR
LIVINGSTONE RIVER
OLDMAN RIVER
WILLOW CREEK
LITTLE BOW RIVER
CLEAR LAKE
TRAVERS RESERVOIR
LITTLE BOW LAKE
CLARESHOLM
BOW
KEHO LAKE
Sept. 1 - 15
After Sept. 15
7
OLDMAN RIVER
9
FORT MACLEOD
LETHBRIDGE
BEAVER CREEK
CROWSNEST RIVER
COWLEY
CASTLE RIVER
PINCHER CREEK
BELLY RIVER
ST MARY RIVER
WATERTON RIVER
6
5
4
COCHRANE LAKE
WATERTON RESERVOIR
ST MARY RESERVOIR
JENSEN RESERVOIR
10 in.
CARDSTON
1
2
3
PAINE LAKE
WATERTON LAKES
100 - 120 Frost - Free Days
More Than 120 Frost - Free Days
11 in.
LOWER ST MARY LAKE
ST MARY LAKE

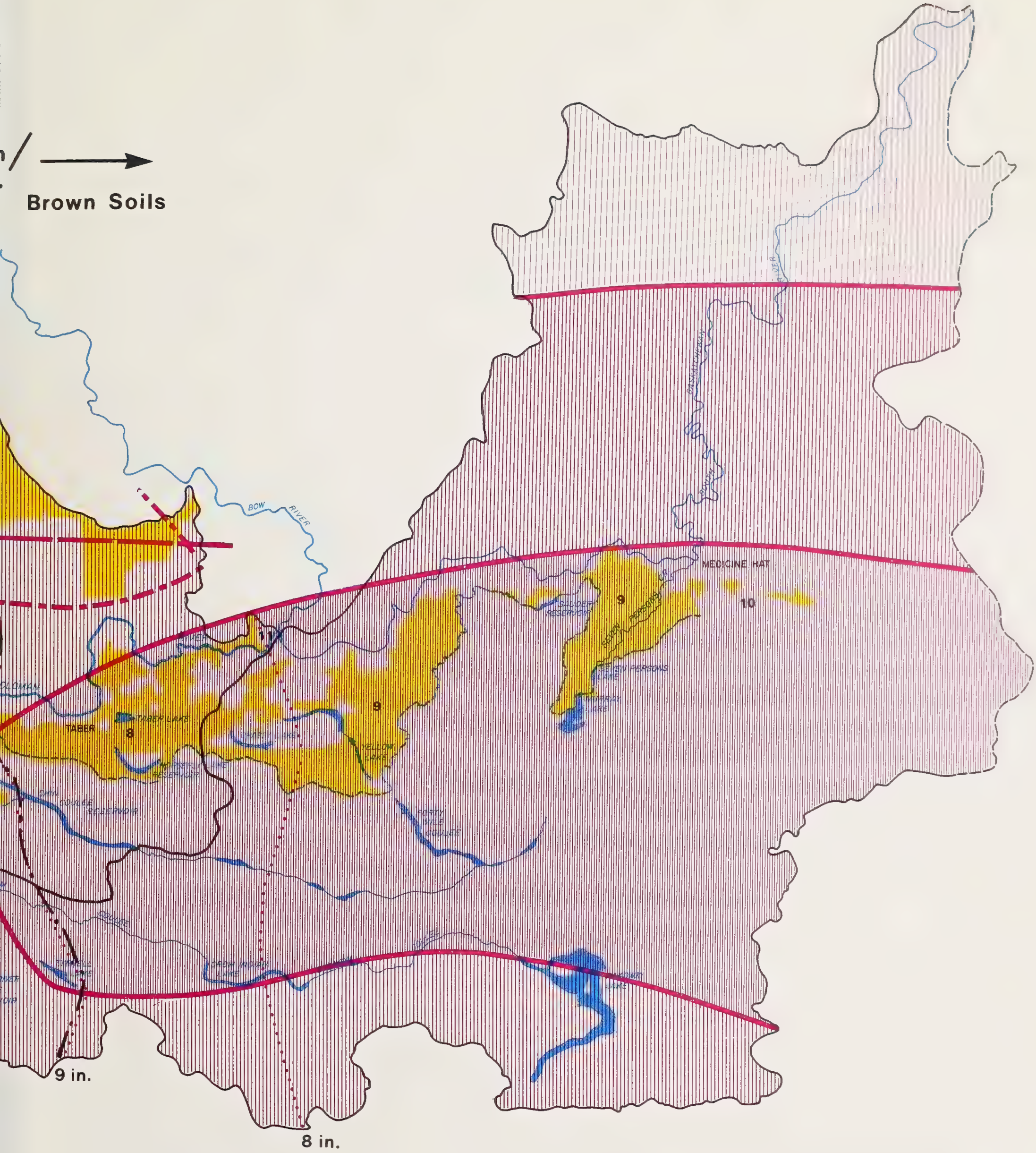

Brown Soils
BOW RIVER
SOUTH SASKATCHEWAN
RIVER
MEDICINE HAT
9
10
SEVEN PERSONS
SEVEN PERSONS LAKE
MURRAY LAKE
OLDMAN
11
TABER
TABER LAKE
8
9
YELLOW LAKE
CHIN COULEE RESERVOIR
FORTY MILE COULEE
COULEE
CROW INDIAN LAKE
PAKOWKI LAKE
9 in.
8 in.

FIGURE 1

PHYSIOGRAPHIC FEATURES OF THE OLDMAN RIVER BASIN

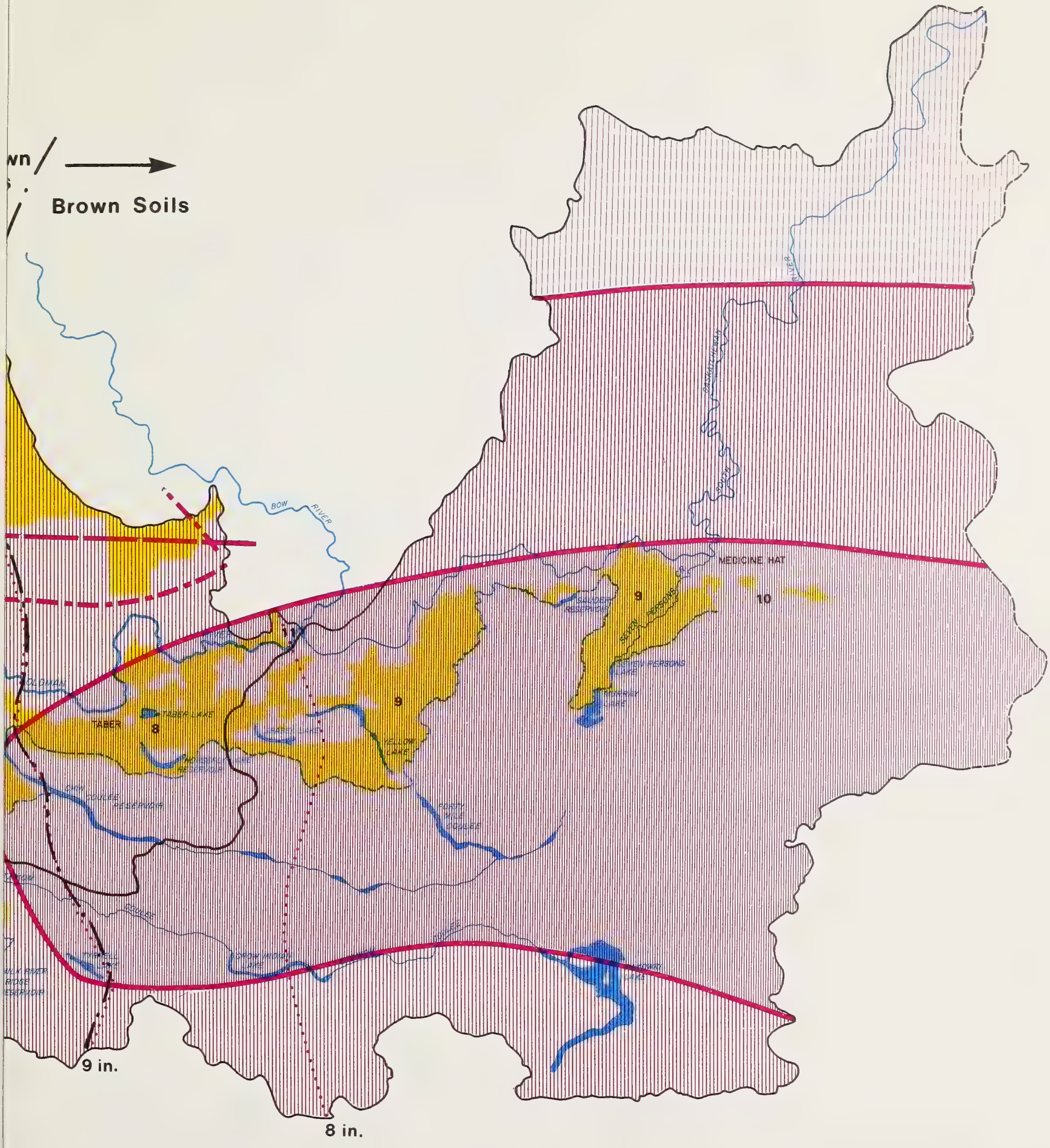
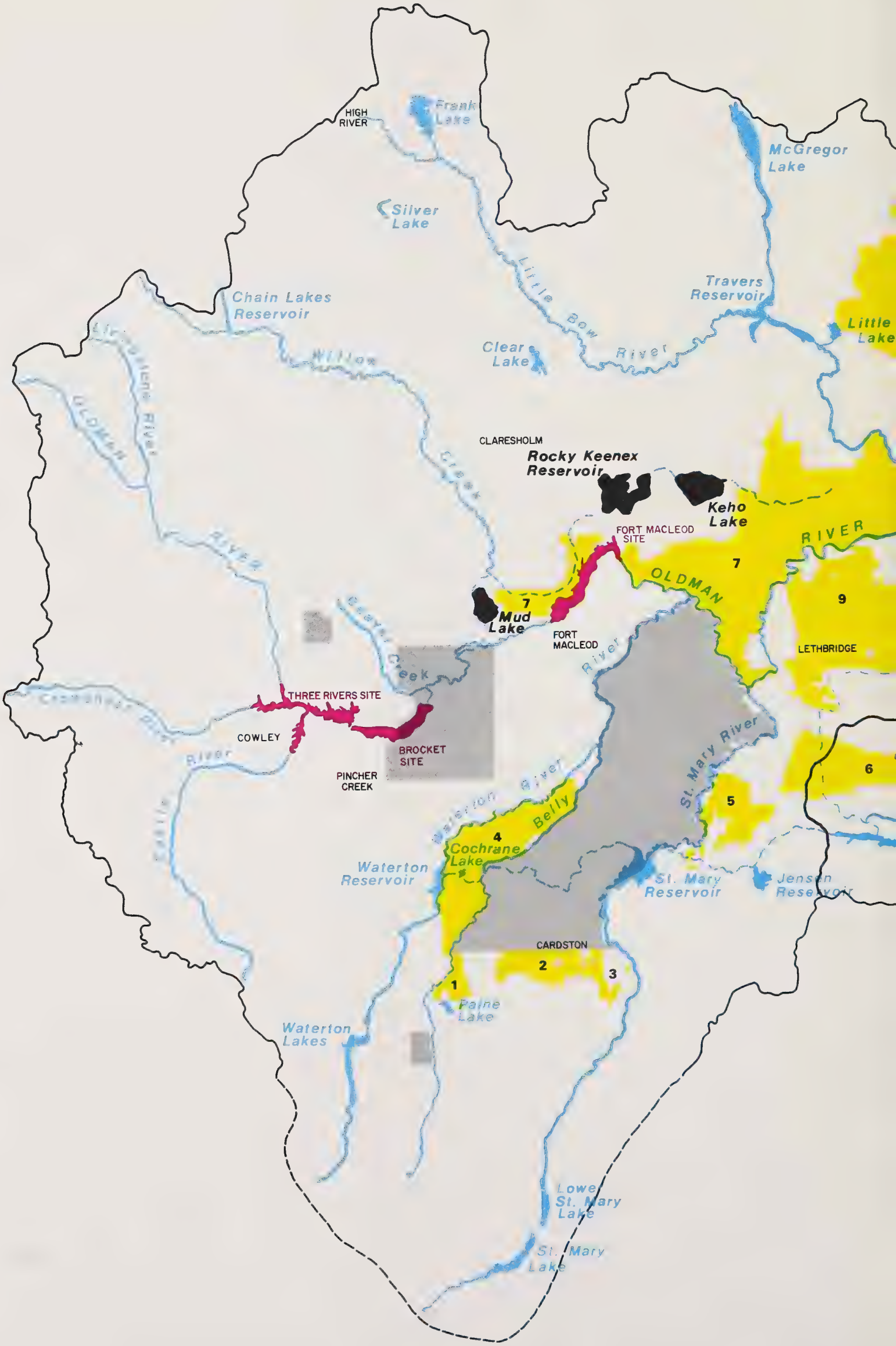

Brown Soils
BOW RIVER
SOUTH SASKATCHEWAN RIVER
MEDICINE HAT
9
10
SAUDER RESERVOIR
SEVEN PERSONS
SEVEN PERSONS LAKE
MURPHY LAKE
OLDMAN
TABER
TABER LAKE
8
9
YELLOW LAKE
CHIN COULEE RESERVOIR
FORTY MILE COULEE
COULEE
CROW INDIAN LAKE
TYRRELL LAKE
RIDGE
LAKE
9 in.
8 in.

FIGURE 1

PHYSIOGRAPHIC FEATURES OF THE OLDMAN RIVER BASIN

LEGEND

Mountain View Irrigation District	1
Leavitt Irrigation District	2
Aetna Irrigation District	3
United Irrigation District	4
Magrath Irrigation District	5
Raymond Irrigation District	6
Lethbridge Northern Irrigation District	7
Taber Irrigation District	8
St. Mary River Irrigation District	9
Ross Creek Irrigation District	10
Bow River Irrigation District	11
Onstream Storage Sites	▬
Offstream Storage Sites	▬


HIGH RIVER
Frank Lake
McGregor Lake
Silver Lake
Little Bow River
Travers Reservoir
Little Lake
Chain Lakes Reservoir
Livingstone River
OLDMAN
Willow Creek
Clear Lake
CLARESHOLM
Rocky Keenex Reservoir
Keho Lake
FORT MACLEOD SITE
RIVER
OLDMAN
7
9
River
7
Mud Lake
FORT MACLEOD
LETHBRIDGE
Beaver Creek
THREE RIVERS SITE
Crowsnest River
COWLEY
BROCKET SITE
PINCHER CREEK
River
Castle
Waterton River
Belly
St. Mary River
4
5
6
Cochrane Lake
Waterton Reservoir
St. Mary Reservoir
Jensen Reservoir
CARDSTON
1
2
3
Paine Lake
Waterton Lakes
Lower St. Mary Lake
St. Mary Lake

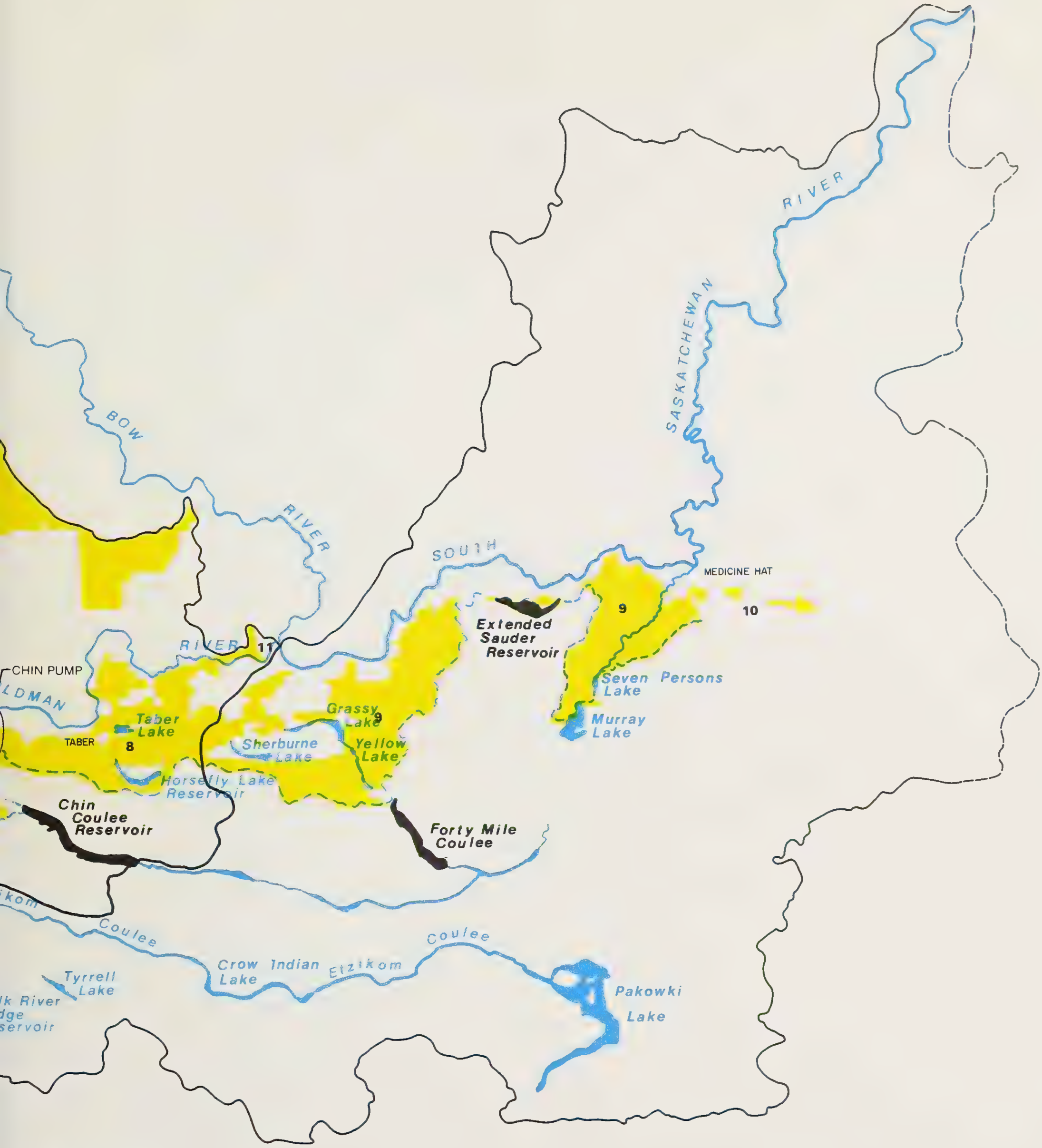

RIVER
SASKATCHEWAN
BOW
RIVER
SOUTH
MEDICINE HAT
9
10
Extended Sauder Reservoir
RIVER
11
CHIN PUMP
LDMAN
Taber Lake
TABER
8
Grassy Lake
9
Sherburne Lake
Yellow Lake
Seven Persons Lake
Murray Lake
Horsefly Lake Reservoir
Chin Coulee Reservoir
Forty Mile Coulee
ikom
Coulee
Coulee
Crow Indian Lake
Etzikom
Tyrrell Lake
lk River
dge
servoir
Pakowki Lake

FIGURE 2

WATER SUPPLY ALTERNATIVES

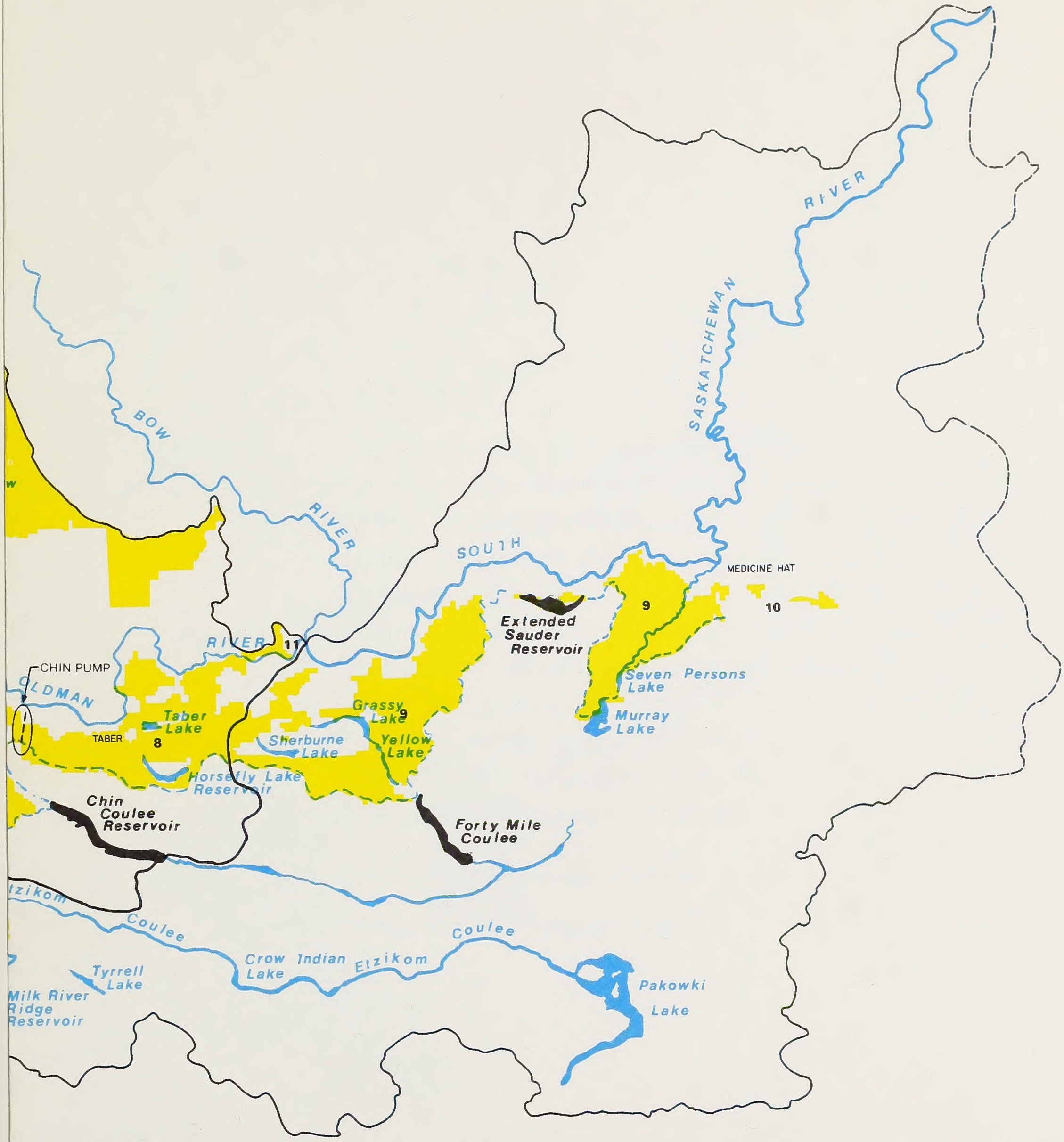

SOUTH SASKATCHEWAN RIVER
BOW RIVER
OLDMAN RIVER
CHIN PUMP
TABER
8
Taber Lake
Sherburne Lake
Horsefly Lake Reservoir
Grassy Lake
9
Yellow Lake
11
Chin Coulee Reservoir
Forty Mile Coulee
Extended Sauder Reservoir
9
MEDICINE HAT
10
Seven Persons Lake
Murray Lake
tzikom
Coulee
Crow Indian Lake
Etzikom Coulee
Pakowki Lake
Tyrrell Lake
Milk River Ridge Reservoir

FIGURE 2

WATER SUPPLY ALTERNATIVES

N.L.C. - B.N.C.
3 3286 06288544 3